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ABSTRACT

This manual, the first of three curriculum guides for an electronics course, is intended for use in a program combining vocational English as a second language (VESL) with bilingual vocational education. A description of the VESL program design appears first. The next section provides a format on developing lesson plans for teaching the technical and general vocabulary contained in each job training lesson immediately after vocational lessons. Specific VESL teaching activities are provided for recognition, production, and application. Lesson plans for vocabulary development follow. Functions (objectives) are correlated to structures and vocabulary and required materials. Glossaries of technical and related general vocabulary follow. The vocational training lesson plans are then presented. They are divided into seven units: electronics math, history of electronics, tool use, meters, nature of electronics, connectors/insulators, components, and resistors. A cover page to each unit provides the unit goal and an overview of the unit. The format for each lesson plan is as follows: teaching materials source, main concepts, technical and related general vocabulary, teaching activity, material and notes, length of lesson, and evaluation. Handouts for each lesson include informational material, homework/assignments, lab experiments, Vietnamese and Cantonese translations, and unit tests. Numerous drawings and diagrams illustrate the text. (YLB)

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ELECTRONICS BOOK I

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Elk Grove Unified School District
Elk Grove, CA

September 1986

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BILINGUAL VOCATIONAL TRAINING

ELECTRONICS

This curriculum has been developed by the Sacramento County Regional Occupational programs and Elk Grove Unified School District as a part of the federal Bilingual Vocational Training Project. LaVina Ward, Director.

The instructional materials were written by the following teachers:

Dennis Johnson, ROP - Electronics
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ELECTRONICS

UNITS

I.	ELECTRONICS MATH	2 weeks
II.	HISTORY OF ELECTRONICS	1 week
III.	TOOL USE	2 - 4 weeks
IV.	METERS	1 week
V.	NATURE OF ELECTRONICS	1 week
VI.	CONNECTORS/INSULATORS	1 week
VII.	COMPONENTS	1 week
VII.	RESISTORS	1 week

SECTIONS

1. Lesson Plan
2. Teaching Materials
3. Homework/Assignments
4. Lab Experiments
5. Tests
6. VESL
7. Vietnamese Translation
8. Cantonese Translation

VESL Curriculum Outline

VESL Curriculum Outline

A. VESL Program Design

B. Lesson Plan for Vocabulary Development

C. VESL Teaching Activities

    1. Recognition Teaching Activities

        a. Repetition drill
        b. Substitution drill
        c. Variation drill

    2. Production Teaching Activities

        a. Dialogue
        b. Speech
        c. Pair drill
        d. Communication grammar

    3. Application Teaching Activities

        a. Total Physical Response
        b. Reading and writing using context clues

D. Specific work and Social Language Vocabulary from which specific structures may be chosen for each VESL lesson. (refer to number)

A. VESL PROGRAM DESIGN

In setting up our vocational-ESL courses, we chose a program that is generally considered the most effective vocational ESL disign. Our program combines VESL with bilingual vocational education. The students receive 3 hours a day of vocational training with a bilingual aide to explain difficult concepts in their own language. In addition to this course, there is a 3 hour job-related ESL course which consists of English for the vocational classroom and the workplace. Students who speak only limited English can begin vocational training immediately by receiving training in their own language and English for their future job. At the beginning of the course students receive heavy support in their own language to make certain they understand the basic concepts of the vocational course and to give them enough success to feel confidence. Gradually this support is taken away until the students are able to function almost exclusively in English. Regular meetings between the VESL and vocational instructor are essential to the success of this program.

The following techniques have been followed by our program:

1. Careful and in-depth planning
2. Careful needs assessment of job-market needs of the prospective trainees
3. A staff that is bilingual and committed to the success of the trainees
4. In-service training for staff
5. Personal and job counseling for the trainees
6. Full-time staff
7. Cross-cultural training in American culture, especially in American employment practices for trainees
8. Bilingual vocational instruction closely coordinated with the ESL instruction.
9. ESL instruction that is job-related and closely coordinated with vocational instruction
10. An advisory committee with representatives from minority community, the vocational skills area and the employment sector
11. Follow-up services for trainees who have completed the program and joined the work force. (Friedenberg p. 10)

The VESL curriculum of our BVT Program was drawn from a needs assessment of the classroom needs and the job world. During the first 3 months most of the time was spent on classroom subject matter because if the students couldn't understand what was happening in the classroom, it would be impossible for him/her to develop skills needed to survive in the job world.

After that, job getting, keeping and moving ahead skills were emphasized. In determining lesson content, the following steps are suggested:

1. Determine vocational topic, i.e. magnatism, electronic components, filling out application forms.
2. Determine the vocabulary, especially technical. Separate the vocabulary needed for recognition and from the vocabulary needed for speaking. Each category can be taught differently. REMEMBER, TEACH THE STUDENTS WHAT THEY WANT AND NEED TO KNOW.
3. Determine any grammar structures that need to be practiced for clear communication. Don't teach grammar rules for their own sake. If grammar is taught, teach it in a communicative way related to a vocational subject.
4. Determine the language functions needed for speaking.
5. Observe pronunciation problems that impede comprehension of message.
6. Determine the cultural behaviors that are different from American behavior because these differences may cause problems on the job site. Some of the problems that we learned about through our students were as follows:

    a. Not asking questions when they didn't understand.
    b. Bringing friends to the work site.
    c. Working during break.
    d. Relations with supervisors and American peeers.
    e. Isolating themselves from American workers.
    f. Interpreting a reprimand as a dismissal.
    g. Business decisions taken personally as rejection.
    h. "Cooperation" in tests or in work place where individual ability is necessary.

B. LESSON PLAN FOR VOCABULARY DEVELOPMENT

Each Job Training Lesson contains Technical and General Vocabulary. The following format is used to teach this vocabulary immediately after vocational lessons. The student demonstrates understanding (listening), speaking, reading, and writing skills using the technical and general vocabulary. For specific VESL teaching activities, see Recognition Teaching Activities, Production Teaching Activities, and Application Teaching Activities.

RECOGNITION

1. The teacher presents vocabulary (terms) clearly and slowly. Use actual equipment or tools whenever possible. Do not write vocabulary on board at this stage.
2. Students answer simple comprehension questions using yes-no response.

PRODUCTION

3. The teacher models key terms in a sentence to demonstrate how vocabulary is used. Ask students alternative or descriptive questions to elicit choice or descriptive answers.
4. Put students in pairs. S1 asks S2 using vocabulary, S2 answers. Reverse S2 asks, S1 answers.

APPLICATION

5. Write vocabulary (words) on board and explain again.
6. Have students read vocabulary list and do a reading-matching exercise.
7. Using context clues, have students fill in blanks using vocabulary.
8. Dictate vocabulary. Students write words. Check for comprehension.
9. Next day, give oral vocabulary test followed by written test.
10. Use total Physical Response Activities to check vocabulary comprehension and production.

C. VESL Teaching Activities

1. Recognition Teaching Activities

RECOGNITION TEACHING ACTIVITIES

DRILL FOR TEACHING SENTENCE STRUCTURE, VOCABULARY AND EVERY DAY LANGUAGE.

A. TEACHING REPETITION DRILLS

1. Model the item (word, phrase, or sentence) twice, having the students listen.
2. Model the item again, having students repeat chorally.
3. Model the item for each student as they repeat individually.
4. Model the item again as students repeat chorally.

If a student has difficulty, we backward build up. Have him/her begin from the end of the sentence and repeat increasingly longer segments of the sentence until the entire sentence is mastered.

EXAMPLE: I calibrate the volt meter.
meter.
volt meter.
the volt meter.
calibrate the volt meter.
I calibrate the volt meter.

B. TEACHING SUBSTITUTION DRILLS

1. Model the basic sentence twice, having the students repeat chorally.
2. Roll-play the substitution.
3. Drill the substitution individually.
4. Drill the substitution chorally again.

EXAMPLE: Go get the volt meter.
soldering iron.
screw driver
wires.

C. TEACHING VARIATION DRILLS

1. Teacher models item as phrase or sentence to have students generate different sentence patterns.
2. Students transform phrase or sentence items into questions. (interrogative sentences)
3. Students transform phrase or sentence items into commands. (imperative sentences)

EXAMPLE:

1. Teacher: Thanh calibrates the volt meter.

   S1 asks: Does Thanh calibrate the volt meter?

   S2 answers: Yes or no.

S1 asks: Who calibrates the volt meter?

S2 answers: Thanh does.

S1 asks: What does Thanh calibrate?

S2 answers: The volt meter.

2. Teacher: Le has the soldering iron.

S1 says to S2: Please get the soldering iron!

S2 says to S1: Solder the chips!

S1 says to S2: Be careful! Don't drop the soldering iron!

S2 says to S1: Watch out! The soldering iron is hot!

PRODUCTION TEACHING ACTIVITIES

A. TEACHING A DIALOGUE

A dialogue is a short conversation between at least two people. It is an excellent method for teaching everyday expressions and useful conversation. To be effective a dialogue should be lively, have fairly short sentences and useful language structure or expressions. Remember to make dialogues as true to life as possible. Use realistic props and actions. Students will remember words and expressions better if you use audio-visual and kinesthetic aids to help them learn. Also, remember to use hand signals to direct group participation. Always teach, beginning with large group, then small group and finally call on individuals when you feel certain they will succeed. (Mouth words).

Process for Teaching a Dialogue:

1. Give a brief introduction of the content of the dialogue. Improve your explanation by using audio-visual or kinestic aids as drawing pictures on the board or using gestures.
2. Act out or read through the dialogue dramatically.
3. Teach 2 lines at a time. Use gestures to help students learn.
    a. line 1 - teacher models twice alone, students repeat twice.
    b. line 2 - teacher models twice alone, students repeat twice.
    c. lines 1 & 2 acted out by teacher and students. Teacher is A and students are B.
    Exchange roles. One group is A, second group is B.
    d. Students practice lines 1 & 2 in pairs for a few minutes.
    e. Call on individuals to play parts in seat.
4. Learn lines 3 and 4, steps a-e.
5. Lines 1,2,3,4 acted out by teacher and students. Teacher is A and students are B. Reverse roles.
6. Students practice lines 1, 2, 3, 4 in pairs.
7. Seated role play.
8. Stand up rile play.

If at any time the students are having difficulty remembering their lines, you must provide supportive learning. Return to repetition part of learning until they are sure of themselves.

Alternate Method for Teaching Very Large Classes

Break large group into groups of 10. Chain drill instead of practicing in pairs.

EXAMPLE:

Bob: Hey Bao. Go get the drill and give it to me.
Bao: Excuse me. Please repeat that slowly.
Bob: I said, "Go get the drill and give it to me."
Bao: Now I understand. Thanks.

B. SPEECHES

To give students confidence in speaking English in front of a large group of people, students gave short speeches from time to time. Subjects ranged from topics of general interest to technical. Because of the students varying ability in English, a structured sample was prepared using the language experience method. The instructor often asked a series of sequential questions to the class. The answers given individually to students were put together into a concise paragraph that explained the subject. The paragraph explained the subject in the students' own language. It was used to teach stress, intonation, phrase reading, pronunciation and oral reading. The following day the lower ability students gave a speech on the same topic using any vocabulary and structure they liked from the class's model. The more advanced students gave a speech on the same topic but used their own language. The steps used are as follows:

1. Instructor asks a question.
2. One student answers it.
3. The instructor writes the answer on the board.
4. This procedure is followed until the paragraph is finished.
5. Instructor reads the paragraph to the class.
6. Stress is written in.
7. Students chorally repeat each sentence after the instructor. (two times)
8. Students read paragraph in pairs several times.
9. Several students read paragraphs individually to the class.
10. The following day students give speeches on the same topic.

Sample Lesson - How to Measure Current

Questions asked to individual students.
1) What is current?
2) What do you use to measure current?
3) What is the basic unit of current?
4) How do you measure current with an ampmeter?
5) What is the last thing you do?

PARAGRAPH WRITTEN COOPERATIVELY BY CLASS

Current is the flow of electrons through a conductor. An ammeter is used to measure current. The ampere is the basic unit of current. To measure current interrupt the circuit and connect the positive terminal of the ammeter to the positive terminal of the power source. Then you connect the negative terminal of the ammeter to the negative terminal of the power source. Read the scale of the meter to know how many amperes you have.

This is an excellent method to use with class when the instructor lacks knowledge about the topic. The instructor asks and students answer. Often argument over the correct answer takes place between students in English. The instructor does not have to feel totally expert in the subject matter.

C. PAIR WORK

The best way to improve English speaking ability is to give the students opportunities to speak. Due to the numbers of students in a class, it is difficult to give each student much individual time to practice. One of the best ways to overcome this problem is to devise speaking practice in pairs. The following example is a pair practice that combines the grammar lesson of count and non-count nouns with the subject matter of electronic components. Use any combination of vocabulary terms and simple grammatical structures.

EXAMPLE - Oral Practice (practice in pairs)

How much, many

a little, a few

QUESTION	ANSWER
How much ________ is required?	2 ________s are required.
How many ______ are required?	3
	Just a few.
	or
	Just a little ____ is required.
	A lot of

Fold your paper in half You ask the question.	You answer the question
1. resistors - 2	1. resistors - 2
2. electrons -3	2. electrons - 3
3. switches - 5	3. switches - 5
4. resistance	4. resistance
5. time	5. time
6. watt - 7	6. watt - 7
7. power	7. power

8. energy
9. ampere - 10
10. multimeter - 6
11. voltage
12. current

8. energy
9. ampere - 10
10. multimeter - 6
11. voltage
12. current

D. COMMUNICATIVE GRAMMAR

You can further improve your students' listening and knowledge of correct verb tense by asking questions about the commands they have learned. Remember to model answers first so they will feel secure. The three kinds of questions you can ask are as follows:

1) Yes/no questions
2) Choice questions
3) Information questions

EXAMPLE

Command Go get the drill.

	QUESTION	ANSWER
Yes/no	Am I getting the pliers?	No, you are not.
Choice	Am I getting the pliers or the drill?	You're getting the drill.
Information	What am I getting?	You're getting the drill.

Bizarre questions will make them pay attention.

Am I getting the drill or taking a bath?

Verb tense

Examples for asking questions:

Simple present

Hai, put the soldering iron away.

Hai puts the soldering iron away everyday.

1. Does Hai put the soldering iron away everday?

   Yes, he does. or Yes, he puts it away everyday.

2. Does Hai put away the soldering iron or the PC board everyday?

3. Who puts away the soldering iron?

4. What does Hai put away?

3. Application Teaching Activities

A. TOTAL PHYSICAL RESPONSE

When you want a clear, direct methodology to teach your students to understand you when you give them commands or describe a process, use the Total Physical Response method (TPR). Students learn to understand and use vocabulary acting out commands and utilizing the senses of sight, hearing and touching. TPR is based on the theory that listening comes before speaking. Students must do a lot of listening before they easily recognize what they are hearing. Once they hear something with ease, they can repeat it.

The methodology also incorporates the idea that through the use of commands and simultaneous physical action, student learning is improved.

GENERAL TEACHING STEPS FOR VOCATIONAL TPR

1. Teacher models whole process 2 times.
2. Teacher models 3 commands at a time. (2 times) Use volunteers to model with you if you like.
3. Students respond to teacher commands with teacher as a model. (large group, small group, individual)
4. Students obey commands without the help of the teacher. (large, small, individual).
5. Students repeat the commands after you as you model action.
6. Teacher does the action and students give the command in chorus.
7. Teacher does the action, students give the command and teacher writes the command on the board. Students copy the commands.
8. Students repeat commands after instructor.
9. Students practice the commands in pairs.
10. Individual students give the commands to the class.

B. READING AND WRITING USING CONTEXT CLUES

Place the following words in the correct place.

hide
damaged
obey
workstation
right place
can you help me?

use
borrow
copy
report
clean
horseplay

common sense
mistakes
injuries
run
sweep
hoard
accidents

1. Walk in the classroom. Don't ____________.
2. No ______________.
3. Keep your ____________________ in order.
4. Use your tools. Don't ____________________.

B. READING AND WRITING USING CONTEXT CLUES (continued)

5. Put your tools back in the ______________. Look at the numbers.

6. Keep classroom ____________________.

7. __________________ the room when it is dirty.

8. __________________________ Mr. Thompson's rules.

9. Don't ________________ parts. Return what you can't ______________.

10. When you don't understand Mr. Thompson, go to him or the aide and ask, "______________________________________".

11. Do not ___________________ answers from other students. When you _____________, you do not learn.

12. Report __________________ and ___________________ to the instructor.

13. _____________ __________________ to the instructor. Don't hide.

14. Report ____________________ tools to the instructor. Don't _____________ them.

15. The best rule is always use ___________________.

Function (The Student Can:____)	Structures & Vocabulary	Materials/Notes
Basic skills		
Recite the alphabet		
Count by 1's, 5's, 10's to 100, 1000		
Work Language multi-digit		
1.1 read numbers (handwriting, typeset, printout)	56135 = 56-135 or 5-6-1-3-5 or 56-13-5	parts, notes, printout forms
1.2 ask for clarification of poorly printed no's.	Can you help me, please? What's this number?	
1.3 read no's. arranged in rows/columns	The first number is_______ . The first number in the second row is______. The last number in the third column is_____.	
1.4 count parts in containers	S1 How many do you have / are there in that___? S2 I have______. There are___in this____.	bin, bucket, basket, bag, envelope

* Throughout this curriculum S1 refers to Speaker 1 for S2 to Speaker 2.

Function (The Student Can: ___)	Structures & Vocabulary	Materials/Notes
1.5 verify the count	S1 Check the count on these. S2 It's O.K. short/shy over S1 How many short/over? S2 ______ extra more short shy	envelope with paper clips inside. tags outside indicating number of parts
1.6 sign-off or bug-off on something	stamp/bug the card sign the card initial the card Would you please, _____	stamp
1.7 sign-off in a specific location	stamp the card in the upper/lower right/left corner, in the middle/center of the circle	

Function (The Student Can:___)	Structures & Vocabulary	Materials/Notes
1.8 Indicate where something has been stamped off.	S1 Does it have a stamp? signature initial S2 Yes in the __________.	cards as in 1.7 already stamped
1.9 Put things away	Put these (bins envelopes etc) on the top shelf. bottom shelf in the middle. middle shelf on the right. middle shelf on the left.	Shelves ...then ditto a hand-out to practice shelving.
1.10 Tell where things are	S1 Where are the bin? S2 On the top shelf etc.	"
SOCIAL LANGUAGE		
1.11 Identify him/herself	S1 What is ______? What's your name? S2 My name is_______. Call me_______. How do you spell___?	discuss nicknames
1.12 Correct someones pronunciation/ spelling of his/her name.		
1.13 Identify his/her dept. & dept. no's.	I work in__(name)_____. That's __(number)_____.	

Function	(The Student Can: ___)	Structures & Vocabulary	Materials/Notes
1.14	Introduce him/herself	Hi! Hello! I'm________. or My name is___ ____. I work in ___ ____.	
1.15	Introduce others in a room	This is ______. That is_________. Over there is_______. ________is over there. The woman on the right is______. on the left in the middle *next to * behind * with the glasses in the blue sweater ________is on the right etc.	
1.16	Identify another person by describing physicial appearance.	S1 Do you know_____? Who is_______? Who's your supervisor? S2 ____is. Do you know her/him? No. What does s/he look like. S1 S/he is tall/short old/young about 30/40 thin/medium stocky pretty (adj) e.g. pretty tall, pretty thin kind of	. Milk and Honey, p.31-5 . Students describe other students . Pictures of leads, production managers, J. Beatty, Ron Beamer et

MORE NOTES: Additional Exercises

To expand Functions 1.1 - 1.10 ask students:

What are you doing?
What did you do?
(vary with she/he, etc.)

READING/WRITING: Ask students to read the information on their ID. cards, deleting names. Have other students guess which card goes with which classmate, from the descriptions. If no ID cards then do the exercise. have students write their own.

Function (The student can:___)	Structure & Vocabulary		Materials/Notes
BASIC SKILLS			
Identify colors and shades of colors.	brown, black, orange, red, yellow, violet/purple, gray/silver, white light/dark shin/dull or flat		Color wheel with spinner old new/coins as paint cards
WORK LANGUAGE			
2.1 Follow single step commands	bend-_______	insert	wires
	twist_______	untwist	pipe cleaners
	hook______	unhook	colored yarns/wools
	wrap around	straighten	
	wind	remove/take out	
	coil	uncoil	
	tight	loose	
	right-side-up	upside-down	
2.2 Repeat instructions to indicate acknowledgement.	S1 Wrap the wire around the pen.		S1 Demonstrates action/ directions.
	S2 OK, Wrap it around the pen, like so like this. this way.		S2 Performs action, repeating direction t indicate acknowledgem

Function (the student can:____)	Structure & Vocabulary	Materials/Notes
2.3 Clarify directions in a process (brushing your teeth)	S1 Remove the cap. S2 cap ? S1 Yes, this is the cap. Squeeze the tube from the bottom. S2 Squeeze? What's that? S1 Yes, like this. Squeeze. S2 lay the toothpaste on the brush. S1 "Did make a mistake?" S2 "What's wrong?" S2 "What should I do now?"	toothbrush, toothpaste S1 should try to use some unusual terms to get S2 to clarify their meaning. Explain before hand that S2 is going to do this and that S1 should clarify and new words. At the end of the exercise review clarification techniques/question.
2.4 Repeat instructions to acknowledge them.	S2 Watch me do it now. S1 OK! S2 Remove the cap, like so. Squeeze the tube.	This function reviews 2.2. It also points to the fact that students can learn some language on the job by trying to use terms/expressions that native speakers have just used. Do this with one or two students to make this point. Then list out any vocab. students want to learn, let students pair-up & practice as an ESL operational drill.

Function (The student can:____)	Structure & Vocabulary	Materials/Notes
2.5 Follow color-linked directions.	S1 Bring me red wires. Bend one red one in half. Twist the ends together Wrap another red one around your finger. Insert the other red one into this hole. (To vary use 4 wires-add one of the other red ones.)	Photo board wires . Direct a student. Explain you'll say it once and that she'll have to clarify, slow you down or whatever. .Have students pair up and practice .Teach structures explicit
2.6 Understand & respond to interruptions.	S1 What are you doing now? S2 I'm bending wires. winding etc. S1 How many are done? S2 _____. S1 Do that one, one more, after that one, then two more, stop. S2 All right.	S2 is given a bag of wires and is doing something to them. S1 is given a piece of paper telling how many wires are needed. S1 interrupts S2 and redirect her At the end, S1 shows the paper.
2.7 Identify common tools.	S1 What's this? S2 It's_____.	Emphasize pronunciation of tools used in assembly are If possible get different types of some tool, e.g. a big/small tweezers (red hd blk. hdle, needle nose).

Function (The student can: ___)	Structure & Vocabulary	Materials/Notes
2.8 Ask for/locate tools.	S1 Did anybody see my _____? use borrow S2 It's right there/over there on the shelf. S1 No. I have another one too. That's my small tweezer. I'm looking for the big one. or Thanks! That it's.	Ask student to leave room. Remove one tool. Let the class put it somewhere. Tell student to return.
SOCIAL LANGUAGE:		
2.9 Describe his/her daily routine.	Simply present tense. Include: drive, carpool or take the bus to work, arrive at work, work until, take a break, return to work, stop for lunch, go back to work.	
2.10 Ask and answer questions about daily work.	Frequency adverbs-every, always, usually, sometimes, seldom, rarely, never. Do you ever_________? Yes, ______. No, _______.	

MORE NOTES: Additional Exercises

- To give further practice to 2.3, 2.4 pick another operation using verbs, such as, squeeze, remove, lay, adverbs like gently, firmly (e.g. using a glue).
- To practice reading. Read bottle tops, packages for single-step instructions.

MORE NOTES: con't.

- To further practice 2.9, 2.10:

  a. Draw a story square about two workers.

	starts work	goes home
Jan	6:30	3:00
Jane	6:45	3:15

practice: before earlier than
after later than

b. Role play - Your friend is thinking of coming to work at ELDEC. She has never never worked in a flex-time company. Explain what you usually do; how flex-time can be useful if you have an emergency or a late night party.

Let your friend clarify anything she doesn't understand.

c. Write and read work schedules.

d. Read an activity schedule from Echo Newsletter.

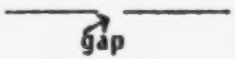
FUNCTION (The student can:___)	Structure & Vocabulary	Materials and No
BASIC SKILLS		
Calculate length of time		
Use/convert fractions to decimals	1/4, 1/2, 3/4 .25, .50, .75	
WORK LANGUAGE:		
3.1 Follow instructions for a new process. (Making a paper hat.)	1. Fold the paper in half with the edge up. 2. Fold the paper from left to right. 3. Unfold the paper, leave a line down the center. 4. Bring the top left corner to the center line. 5. Bring the top left corner to the center line. 6. Fold the bottom rectangular piece up. 7. Turn the hat over. 8. Fold the other bottom piece up. 9. Try on the hat to see if it fits.	paper squared off Instructor shows class one hat. Asks for a volunteer. Tells student she will both demonstrate and direct student in making hat. Student works alongside the instructor, clarifying, acknowledging terms.
3.2 Do a new process immediately after having had it demonstrated.	First then next What next? What now? Show me again.	Students try to make hats and talk their way through the process.
3.3 Read a simple diagram to do a process		orgami
3.4 Direct someone else using a diagram.		orgami

FUNCTION: (The student can:___)	Structures & Vocabulary	Materials/Notes
3.5 Follow a procedure to assemble something.	S1 1. Insert the end of the hose here. Rotate it clockwise until it locks. 2. Join the metal extension wands. Depress the locking buttons of one wand and push this into the other. 3. Push the assembled wands into the floor nozzle. Align the wand hole with the button on the floor nozzle. 4. Push the curved want into the straight wands. Aligh them.	Cannister vacuum
3.6 Follow a procedure for taking something apart.	5. Depress Detach/take off Counter clockwise pull out	Cannister vacuum
3.7 Seek and give confirmation that a task is completed	S1 Did you finish yet? S2 No, not yet. Two minutes. Yes, done. " /no, almost. S1 How much did you finish? do you have left? to go? S2 1/2, 3/4, etc.	
3.8 Report time needed to finish a task.	S1 When did you start? (3:00) When did you finish? (3:15) How long did it take? (15 minutes) Report it like this--(.25)	Oral/written problems
3.9 Talk about past events		Milk & Honey, P. 105-111

More Notes: Teaching activities

- To further practice assembly directions/terminology bring in examples of things that can be taken apart and put together e.g. ball point pens, flashlight

FU ON (The student can)	Structure and bulary	Materials and N
Basic Skills		
*identify lines/points *identify parts/whole	parallel,perpendicular, point, diagonal, horizontal, vertical, curved, straight	Nucleus Unit 1 pages 1 - 2
	----consists of----	letters of the alphabet
*identify common figures	square, rectangle, triangle, circle, semi-circle, angle	The letter A consists of 2 diagonal lines and a horizontal line. A square consists of----
4.1 Follow instructions for using a tool or instrument.	S1 We're going to do some measurements. Lay the _____scale flat against the line. Be sure that / Make sure that (using the right side.)	6" scale
4.2 Measure length, width, height, diameter.	S1 Measure the length etc. How long is the long/length? wide/width etc.?	10 objects to be measured
4.3 spot check work	S1 Check your neighbors work. Just check the first one, the last one and one in the middle. Then be sure to initial the ones you checked.	
4.4 report finished work	S2 Did you finish yet? Are you finished? Are you done?	Appoint a student to go around and check if others finished.
4.5 follow instructions for constructing lines and shapes of a specific size.	S1 Draw 3 lines. Make the first one 2" long and vertical. etc.	

FUNCTION he student can)	Structure and Vo ulary	Materials and Not
4.6 Compare lengths, widths, diameters, gauge	longer, shorter, wider, narrower trace a line around a circle.	various lengths string, size pipe or tubes, guage wire
4.7 estimate the length/size of a line	S1 How long do you think this book is? S2 About ______.	
4.8 round off the size of something.	S1 Measure these lines. Tell me if they're precisely, exactly/ nearly, roughly the size stated.	worksheet. _________(1")
4.9 measure a space or a gap	S1 Measure the gap between these two lines.	
SOCIAL LANGUAGE		
4.10 Describes a past event at ELDEC	S2 Did you hear about______? S1 No what happened? S2 She found out she was allergic to flux. S1 What? What do you mean? How did she find out? S2 She notices her skin was always red. So she went to the doctor. He told her to rub some of the things she was uses at work on a band-aid, one by one. Then to put the band-aid on her arm, and to pay attention to the reaction. S1 And? S2 She tried a few things. Flux turned her skin red. S1 So what's she going to do? S2 She told her lead and supervisor. They just assigned her other jobs. S1 That's nice.	Ask comprehension questions. Try to get students to talk about past experiences that happened to them.

MORE NOTES AND ACTIVITIES:

* Try to write up the last dialogue as a small group story. Read it. Ask Questions.

Develop it into a strip story.

FUNCTION (The student can)	Structure and Vocabulary	Materials and Notes
Basic Skills		
*identify objects	bell shaped, star shaped, wedge shaped	Nucleus
Work Langage		
5.1 follow directions to assemble something	Key Terms insert press hard Hold the rattle firmly. Slip a dics over. Let it rotate freely. Test it by sliding the discs back and forth and by spinning them.	Tinker toys Have one student leave the room. Make a rattle. Let the classmates think of directions. When directions are complete invite the student back. Let the class direct her. She should clarify/confirm instructions and make the rattle
5.2 follow assembly directions	Key terms Rock it gently.	Tinker toy balance bird.
5.3 describe an assembled object.	It has consists of ___	balance and rattle
5.4 describe common classroom objects in terms of physical appearance.		
5.5 Take apart assembled objects.		
5.6 Build something with common shapes.		Wood blocks, place two students back to back. Let them practice clarifying, confirming info.
5.7 Identify differences	I put________ She put________ This should_______	Students describe differences in structures. Look for reversed, not centered, wrong size.
5.8 Report finished work	S2 Have you finished yet? S1 Yes, I have. No, I haven't. S2 How far have you gotten? S1 Half done. Two-thirds done.	Contrast: Did you? Have you?

UNIT

FUNCTION (The student can)	Structure and Vocabulary	Materials and Notes
Social Language		
5.9 Discuss life in	S1 How long have you lived in Seattle? Did you live in another part of the states before? Where do you live now? How long have you lived there?	
	S1 Have you ever seen _____? eaten at_______? gone to _______? tried______?	
	S1 Yes, I have once twice a few times.	
	Have you? No, I haven't. What is it?	

Further Notes and Teaching Activities:

- To further practice social language and reading bring in example announcements. From cafeteria notice board e.g. (garage sale, Kingdome nite etc.).

FUNCTI[illegible] (The student can)	Structure a[illegible]ocabulary	Materials and M[illegible]
Basic Skills		
* recognize sequences and pattern	every other one alternating every third one fourth etc	Letter sequences aB cD a b c D etc
Work Language		
6.1 Identify differences	S1 They're the same/different There's a line missing. an extra line. The line isn't routed the same. The line doesn't connect the same points.	Prince/Gage Worksheets Students compare model to samples describe the difference
6.2 Direct someone to -- Correct something	**Key terms** Remove Replace Connect Add Reroute	
6.3 Make modifications in something.	S2 Write the alphabet using capital and small print. Make every other letter capital. S1 ...... S2 Hold it. Change that. Make it all capital.	Discuss revisions, changes, modifications.
6.4 Measure lines (revised exercise)	S2 Draw a 3" line. Use this ruler Pay attention to the ruler. It is a space. Line up the ruler from this point on. S2 Draw a 6" line now. Hold it. Change that to 4 1/2".	plastic rulers Ask class what revision has been made in this exercise. Ask what revision has been made Practice directing, interruptin revising. We extend, shorten-lengthen.

UNIT 6

FUNCTION (The student can)	Structure and Vocabulary	Materials and Notes
6.5 Discuss factors in terms of enough/too much	enough/too much sufficient, insufficient excessive	Nucleus, p. 60-64
Social Language		
6.6 Comment on an important personal occasion	Formula for congratulating or condoning Cue: Mary's child is sick. S1 Is that so? I'm sorry to hear that. Cue: Sue's getting married. Is that right? Congratulations on the wedding! Will she have an engagement party?	Cue's for birth, death, illness, retirement, layoff, graduation, accident.
6.7 Comment on objects	S1 Is that a new_____?	picutres, cars, hairdos, clothes

Further Notes, Activities

To extend 6.6, 6.7 bring in potpourri readings from Echo. Role play comments.

FUNCTI[illegible] The student can)	Structure and [illegible]cabulary	Materials and No[illegible]
Basic Skill		
Work Language		
7.1 Ask for help explain how to operate, use a piece of equipment	a. S1 Can you show how to use this? S2 Sure. First, _____.	wire stripper wire check to see if student uses, Insert, check to be sure, release, etc.
	b. -plug in recorder -push the eject button to open the recorder. -insert a casette and close the cover. -push/depress fast forward to advance the tape. -push the rewind button to rewind -push the play button to listen to the tape -push the play and record buttons together/simultaneously to record. -push the stop/eject button to eject or release the tape.	Casette player
7.2 explain why something was done	S1 Why did you_____? S2 In order to _______ to _______. So that_____.	Refer to 7.1

FUNCTION (The student can)	Structure and Vocabulary	Materials and Notes
7.3 call attention to a malfunction/problem	S1 Can you help me? take a look at this. come here.	Zippo lighter
	S2 What's the matter? problem?	Demonstrate the lighter. Tell the class you're going to read a conversation about it. Ask questions. Then let students practice.
	S1 I think there's something wrong with this lighter. It must be broken.	
	S2 How do you know? What's it doing?	
	S1 The flame is too high.	
	S2 I see. Have you adjusted the set screw?	
	S1 Oh! No. I Haven't. Maybe that's it. How do you do that?	
	S2 Let me show you. Just turn this until the flame goes down.	
	S1 I see thanks. (revise for no flame/add fluid, too low adjust).	
	b. S1 This scale must be broken.	scale
	S2 Why?	
	S1 I should be 138 lbs. This says 145 lbs.	
	S2 I see. Have you looked at the zero set.	
	S1 No I haven't.	
	S2 Get off. Let me see. It's 7 lbs. off. Turn it back.	

UNIT 7

FUNCTION (the student can)	Structure and Vocabulary	Materials and Notes
Social Language		
7.4 Greet another worker: Comment on appearance	S1 You look tired. S2 I am. My child was sick all night. I came to work an hour later than usual. S1 Go to sleep early tonight. Get some rest. Two days later....... S1 You still look beat. S2 Every other day something else happens. My kid was sick again. I'm beat! S1 Lucky thing we've got flex time.	Read and ask questions. Then act out.
7.5 Comment on important personal occasion	Formula for congratulating or condoning Cue: Sue's child is sick. S: Is that so? I'm sorry to hear that. Is it serious? Cue: Joan's getting married. S: Is that right? Congratulations on the wedding. When's the engagement?	Cue for birth, deaths, illness, birthday, retirement, layoffs, graduation
7.6 Comment on objects	S1 Is that a new______? S2 Yes. It is. No. I've worn it before. had it a while. S1 Is that right/so? It's nice. I like it. It looks new.	pictures of cars, hairdos, clothes, etc.

More I[illegible]es: Teaching Activities

- Potpourri stories in Echo are a resource for reading and gathering role play reactions.
- The Birthday

  Strip-o-grams, balloon-o-grams and other services are more and more common in-company for birthday parties. Ads from The Weekly and stories in there might be appropriate/funny stories for reading/discussion.

- Alarm clock

  A story about a worker who forgot to adjust/set her clock for daylight savings, or standard time is another reading topic. This could then be converted to a dialogue/role play.

FUNCTION (The student can:____)	Structure and Vocabulary	Materials and Notes
WORK LANGUAGE		
8.1 Understand conditional statements	S1 Verify the count on these. If its short indicate. So is the 3rd box. If its over, mark the 2nd box. If its ok, check the 1st box.	clips, envelopes
8.2 Explain to someone how to operate a machine with many variables. (a car)		Prince/Gage Consumer material--a car (role play)
8.3 Explain bureaucratic procedure/police	S1 What do you have to do to get a driver's license? S2 You have to fill out an application. " " take an eye test. " " pay an application fee. " " show proof of age. " " take a written test. " " take a driving test.	Milk & Honey get a car loan open a savings account
8.4 make a suggestion		Milk & Honey, p. 180

FUNCTION (The student can:____)	Structure & Vocabulary	Materials/Notes
9.1 Make Suggestions		Values clarifications
9.2 Prioritize, rank items		Values clarifications
9.2 measure his/her own values and compare to American values, and his/hers cultures values.		Cultural awareness resource guide
9.3 Describe review policy		

Notes & Teaching Activities

- Read a blank performance review form. Let students self-evaluate. Let students consider form in light of American values.

- Read *Echo* on *Safety* (Feb. '83) Develop an activity for giving suggestions.

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

HISTORY OF ELECTRONICS

microprocessor
power consumption
Ionization
optical smoke detectors
body scanner
breakerless electronic ignition systems
optical (fiber-optic)
industry-standard

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

HISTORY OF ELECTRONICS

elektron
magnetism
loadstone
electroscope
electrical charge
static electric generator
sulphur ball
electrostatic induction
conductors
insulators
vitreous
resinous
capacitor
electrometer
inverse squares
dissimilar metals
voltaic pile
deflects
a suspended magnet
electromagnet
voltage
resistance
discdynamo
arc lamps
computer operation
electromagnetic radiation
carbon-filament lamp
incandescent lamp
radio telegraph messages
ship-to-shore wireless
cathod-ray oscilloscope
spark-gap transmitters
transatlantic wireless message
high-frequency alternator
two-element thermionic
ilertzian waves
diode tube
crystal detector
carborundum
audion tube
three element device
transatlantic radio telegraphy communication
electrical wave filter
broadcast radio station
superheterodyne circuit
iconoscope TV camera tube
kinescope
radio astronomy
microwave oscillator
diathermy machine
orthicon camera
radio-detection device
digital computers
automatic-sequence-controlled calculator
amplified
semiconductor crystal
UnivacI computer
transistorized
beam maser
laser
miniaturized
integrated circuit
chip of silicon
nuvistor
thimble-sized vacum tube
planar process
solid circuit series 1
epitaxial process
IC fabrication
solid-state laser
signetics
diode-transistor logic
the silicon transistor
microwave oven
varacator diode
voltage-variable capacitor
electronic tuning
silicon-controlled rectifier (SCR)
orbital satellite
gas-discharge numerical readout tube
nixie
light-emitting diodes
satellite relayed communication
dual-inline-package (DIP)
magnet-bubble devices
random-access memory (RAM)
magnetic cores
MOS/LSI

GLOSSARY

ELECTRONCIS

TECHNICAL VOCABULARY

TOOL USE

treadle
stranded wire
tappered hand reamer
tinning
tin snips
trace
interconnecting
twist-on connector
rat-tail joints
twist drill
vise
wire strippers
electronics
corrosion
wattage
chassis wiring or hand wiring
spaghetti
PC component mounting
rat-tail
tap or tee
western union
electrical junction box
solderless connectors
wire nuts
crimping tool
bake the board
expose
rinse
etch

GLOSSARY

ELECTRONICS
TECHNICAL VOCABULARY

TOOL USE

adjustable wrench
adjustable jaw size
stationary jaw
assembly
aviation snips
sheetmetal cutting shears
compound
ball-peen hammer
rounding off
rivets
box and pan brake
cable ties
nylon belts or straps
self-locking buckle
center punch
wandering
chassis
circuits
mounted and wired
chassis punch
component
conductor joints
approved insulation
desoldering tool
molten solder
suction force
diagonal-cutting pliers
motorized tool
drill press
electrical connection
continuous wire
electrical tape
etching
etching solutions
ammonium persulfate
ferric chloride
file
flux
oxygen
oxidation
rosin flux
paste
gauge
hacksaw
forward motion
hand punch
handle/frame unit
hardware
harness
heat sink
metallic tool
heat shrinkable tubing
insulating tubing
insulation
lacing
long-nose pliers
magnet wire
clear coat
enamel
varnish
mechanical connection
terminals
twisting
bending
nut driver
open-end wrench
portable electric drill
printed circuit board
resist
screwdriver
side cutter pliers
lineman pliers
gripping
slip joint pliers
solder
alloy
solder joint
soldering iron
pencil iron
solderless connector
crimp
lug
solid wire
splice
squaring shear
tap splice
rat-tail splice
stationary equipment

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

METERS AND METER READING

VOM
AC
DC
is treated
zero adjustment
polarity
lead placement
input jacks
polarity switch
function-range switch
false reading
interpolated
meter bearings
carbon composition resistors
tolerance

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

NATURE OF ELECTRICITY

ampere
atom
protons
electrons
neutrons
atomic number
atomic weight
element symbol (copper)
complete circuit
conductor
control
current
electron
electron shell
maximum population
load
neutron
nucleus
core
proton
supply
sclar cells
valence shell
volt
voltage
electromotive force
flourine
lithium atom

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

CONDUCTORS AND INSULATORS

- chain reaction
- chemical stability
- conductor
- dielectric
- electrical impulse
- free electron
- insulator
- semiconductors
- germanium
- speed of light
- electrical impulse
- stripping
- solid wire
- thick copper thread
- physical movement
- transformers
- mechanically weak
- circuit point
- wire insulation
- associated with
- stranded wire

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

COMPONENTS & SWITCHES

abnormal circuit
closed circuit
inductor
momentary switch
neon lamp
ionizes
normal circuit
open circuit
parallel circuit
shunt
branch circuit
potentiometer
resistor
specific opposition
series circuit
series parallel circuit
series-parallel circuits
combination circuits
shorted circuit
silicon controlled rectifier
slide switch
speaker
switch
push-button
slide
toggle
micro
rotary
single pole single throw
double pole single throw
single pole double throw
double pole double throw
toggle switch
snap action
transformer
transistor
amplify
xenon flashtube
strobe lights
photographic strobes
carbon composition resistor
tubular capacitor
electrolytic capacitor
mylar capacitor
variable capacitor
silicon controlled rectifier
cathode
anode
inductor (coil)

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

ELECTRONIC CURRICULUM

adjustable resistor
carbon composition resistor
ohmic value
color code
conductance
film resistor
carbon composition resistors
fixed value resistor
ohmic value
rheostat
potentiometers
wirewound resistor

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

ELECTRONICS MATH

electrical measurement
volts
ohms
amperes
millivolts
microamps
kilohms
scientific notation
electrical formulas
electrical quantities

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

TOOL USE

general purpose
identified
satisfactory
absolutely
excess
slipped over
shrink
accidental shock
lacing cord
objects
incorporate
solidifies
rapidly
inserted
connection
strands
flexible
scissors
firmly
parallel
immediately
upon completion
remedies
visual
alert
grab
enjoyable
hints
super builder
suggestions
as a rule
reliable
unique
artwork
photograph

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

METERS AND METER READING

in series
in parallel
improperly
consult
noticeable
is equipped with
as when
are unsure of
not to turn down
precautions
necessarily
alive
severe shock
respect it
meter scale
encounter
perpendicular
indicate
estimate
reasoning
respectively
multi-function
overall
actual error
color code

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

NATURE OF ELECTRICITY

nature
particle
characteristics
periodic table
the majority
potential difference
sketch

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

CONDUCTORS AND INSULATORS

dominoes
rapid order
toppling
tendency
depending upon
atmosphere
in turn
flexibility

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

COMPONENTS & SWITCHES

sensitivity
configurations
robbing the load device of
unintentional
portion

ELECTRONICS
RELATED GENERAL VOCABULARY

ELECTRONIC CURRICULUM

impractical
percentage
in relation to
power ratings

GLOSSARY

ELECTRONCIS
RELATED GENERAL VOCABULARY

ELECTRONICS MATH

technical glossary
basic unit
fundamental
abbreviations
prefixes
conversion
process
equivalent form
decimal point
decimal fraction
establishes
exponent
indicates
formula
mathematical rule or procedure
equation
power of ten
metric term
mega
kilo
milli
micro
pico
informational handout
short cut
method
keep track of
computations
regular
relationship
decimal number
positive powers of 10
negative powers of 10
translate
positive
original number
negative sign
dividing
simplifies
various
similar units
likewise
involves
performing
desired
determine
direction
statement
mathematical recipe
operations
result
unknown value
variable
constant
mathematical function

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

HISTORY OF ELECTRONICS

statesman
philosopher
curious
phenomenon
electricity
distinguishes
compass
navigation
physician
possessed
properties
detecting
magnetism
body
transmitted
device
independently
predecessor
resistance
presented
theory
supervises
installation
patents
forerunner
commercial
authorized
application
extensively
shattered
versions
swallowed
heralded
thimble-sized
evaporation
consisted of
mainstay
diffusing
wafers
feasibility
available
launched
via
decade
culminated
break-throughs

prior to
spearheads
visability
technology
upgrades
emerges
due to
density
dissipation
financially
is capable of
analyzing
generation
pre-assembled
feat
experimentation
appropriate
deliver

UNIT I

TITLE OF UNIT: Introduction to Electronic Math Fundamentals

Time Allocation: 2 weeks

Unit Goal:

To investigate and reappraise a variety of mathematical competencies acquired in previous courses, and to utilize those fundamental skills as a foundation for introducing the principals of technical math.

Overview:

It was presupposed that basic mathematical skills have been presented to the student prior to this course. This unit was designed to review those competencies and to inform students in terms of related mathematical skills that can greatly support further technical achievement.

The beginning thrust of this unit then is obvious and important, to omit such a review would be a serious mistake. For many students a short, informative review will quickly re-establish their mathematical skills.

The topic of scientific notation may take a substantial amount of class time during instruction, however, the skill gained in handling numbers will be a valuable asset for the student.

Next, conversion of units should be presented. The importance of this topic cannot be overstated. Utilize many practice sessions and remember "repetition is the mother of learning."

ELECTRONIC CURRICULUM

VOCATIONAL TRAINING LESSON PLAN # 1 Electronics Math

Teaching, Materials Source see Ref pg 1.
Chapter ______, pages ______
Lab Manual pages ______
Additional Instructor Materials Grob, Basic Electronics

Main concepts student will learn:

1. Demonstrate through problem solving the proper procedures to follow when completing an addition, subtraction, multiplication and/or division problem.
2. Apply the theory of scientific notation or "powers of 10" and successfully work a variety of problems as provided by the instructor.
3. Manipulate the decimal point correctly when converting common sub units (decimal multipliers) to other units as directed.

Technical Vocabulary

see Glossary

Related General Vocabulary

Use any words you need from the definitions in the Glossary.

Teaching Activity

Lecture
Demonstration
Practice time in class
Begin to teach related use of the scientific calculator Texas Instruments TI-30 II

Length of Lesson

2 weeks

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

Materials and Notes

Each student must have his/her own calculator.

Instructor References:

Basic Mathematics for Electricity and Electronics. Bertrand B. Singer, McGraw-Hill Book Co., 1978. Chapters: 1-3.

Basic Mathematics for Electronics. Nelson M. Cooke and Herbert F. R. Adams, McGraw-Hill Book Co., 1976. Chapters: 1-6, 7, and 20.

Vocational and Technical Mathematics in Action. Samuel Levine, Hayden Book Co., 1970. Chapters 1-5, and 10.

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

BASIC UNIT:	The fundamental or total value of a number or electrical measurement, written without abbreviations or prefixes. For example; volts, ohms and amperes are basic units, while millivolts, microamps, or kilohms are not basic units. 3k ohms can be expressed as the number 3000 ohms which is a basic value.
CONVERSION:	The process of changing a number or expression from one form into another equivalent form. Example: convert the number 5000 into scientific notation: 5×10^3.
DECIMAL POINT:	A dot or point which separates the whole number from the decimal fraction. The location of the decimal point establishes the value of the number. 57.25 decimal point 437.5 does not equal 43.75.
EXPONENT:	A number placed to the right and slightly above another number. The exponent is often called the "power," and indicates how many times a number is to be multiplied by itself. Example: 6^4 exponent means 6 x 6 x 6 x 6 = 129
FORMULA:	A mathematical rule or procedure written in the form of an equation or mathematical sentence which contains an equals (=) sign between the known and unknown values. Example: $E = I \times R$ this formula explains how to find the value of "E" by multiplying the value of "I" times the value of "R".
KILO:	A prefix meaning 1000 (thousand). Abbreviated k. Example: 15k means 15000.
MEGA:	The prefix meaning 1,000,000 (million). Abbreviated M. Example: 5M means 5,000,000.
MICRO:	A prefix meaning .000001 (millionths). Abbreviated μ. Example: 6μ means .000006.
MILLI:	The prefix meaning .001 (thousandths). Abbreviated m. Example: 3m means .003.
NANO:	A prefix meaning .000000001 (billionths). Abbreviated n. Example: 8n means .000000008.
PICO:	The prefix meaning .000000000001 (millionths of a millionth). Abbreviated p. Example: 4p means .000000000004.
POWER OF TEN:	An exponent or power of the number 10 which can be used to abbreviate numbers such as 1,000,000 (10^6) or .000001 (10^{-6}). power of ten expression

Name: ______________

Date: ______________

Period: ______________

③

PREFIX: A metric term or letter abbreviation located just before the electrical unit and used as a short-cut in expressing numerical values. There are 5 common electrical prefixes, mega, kilo, milli, micro, and pico. Example: 7kV is equal to 7000V.

prefix ↑ k — V ← electrical unit

SCIENTIFIC NOTATION: A method of expressing either very large or very small numbers by using a number between 1 and 9.999... times a power of 10. Example: 2.4×10^5 is equavalent to the number 240,000.

Remember these:

mega = M
kilo = k
basic unit •
milli = m
micro = μ
nano = n
pico = p

SCORE:
GRADE:

Name:
Date:
Period:

WORKSHEET

VOCABULARY - SCRAMBLED WORD PUZZLE

Unscramble the letters below to uncover the terms.

EXAMPLE:

A.	AEXEPML	A. EXAMPLE
1.	LOIK	1.
2.	AGEM	2.
3.	ONNA	3.
4.	ILMLI	4.
5.	IRMCO	5.
6.	CPOI	6.
7.	MOFURAL	7.
8.	SINNOVRECO	8.
9.	NETPONXE	9.
10.	IERPXF	10.
11.	SCBIA NUTI	11.
12.	MCIEDLA TINOP	12.
13.	IIICCFSTEN TATNNIOO	13.
14.	WOPRE FO NET	14.

SCORE:

GRADE:

Name: ______________

Date: ______________

Period: ______________

WORKSHEET

SCIENTIFIC NOTATION

1. In the number 4^3, the "3" is called an __________. 1.

2. When using exponents of the number 10, the exponent is often called a ________ __ _____ 2.

3. What is the numerical value of the expression 3^3? 3.

4. To be in proper form, a scientific notation expression uses a number between A)__________ and B)__________ times ten to a power. 4A. 4B.

5. When converting the expression 7.6×10^{-3} to a regular number, the decimal point should be moved to the __________ three places. 5.

Convert the following numbers, expressed in scientific notation, into "regular" numbers.

Figuring Space

6. 5×10^2 6.
7. 4.65×10^4 7.
8. 5×10^{-3} 8.
9. 6×10^0 9.
10. 3.3×10^{-5} 10.
11. 9.5755×10^3 11.
12. 2.125×10^{-2} 12.

Convert the following "regular" numbers into a proper scientific notation expression.

Figuring Space

13. 300 13.
14. 650000 14.
15. .0083 15.
16. .100 16.
17. 7 17.
18. .000000000012 18.
19. .0015 19.
20. 386.5 20.

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

MULTIPLICATION AND DIVISION USING SCIENTIFIC NOTATION

Complete the following problems show your work, and record your results in the answer boxes.

1.

$$\begin{array}{r} 5 \times 10^{3} \\ \underline{\times \quad 2 \times 10^{2}} \end{array}$$

Convert to proper form

2.

$$\begin{array}{r} 52 \times 10^{5} \\ \underline{\times \quad 11 \times 10^{3}} \end{array}$$

Convert to proper form

1. ____________

2. ____________

3.

$$\begin{array}{r} 3.6 \times 10^{-3} \\ \underline{\times \quad 5 \times 10^{-6}} \end{array}$$

Convert to proper form

4.

$$\begin{array}{r} 24 \times 10^{-12} \\ \underline{\times \ 1.2 \times 10^{6}} \end{array}$$

Convert to proper form

3. ____________

4. ____________

5.

$$\frac{42 \times 10^{5}}{2 \times 10^{3}}$$

Convert to proper form

6.

$$\frac{753 \times 10^{3}}{3 \times 10^{-3}}$$

Convert to proper form

5. ____________

6. ____________

7.

$$\frac{25 \times 10^{-9}}{4 \times 10^{6}}$$

Convert to proper form

8.

$$\frac{1.56 \times 10^{-6}}{13 \times 10^{-3}}$$

Convert to proper form

7. ____________

8. ____________

SCORE:

GRADE:

Name: ___

Date: ___

Period: ___

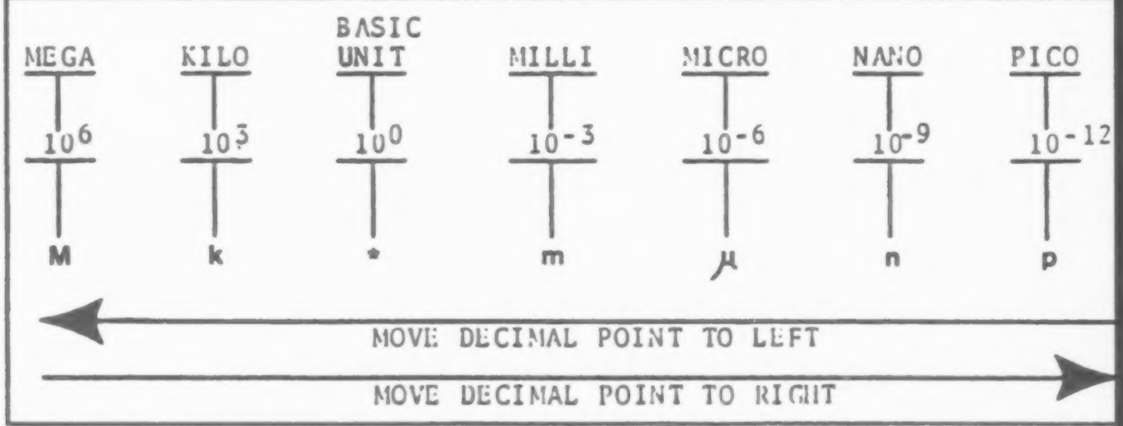
WORKSHEET

ELECTRICAL UNITS AND CONVERSIONS

Complete the chart below:

UNIT	ABBREVIATION	NUMERICAL POWER OF TEN	EQUIVALENT
MEGA			
	k		
BASIC UNIT			10^0
		.001	
			10^{-6}
NANO			
	p		

Use this conversion chart to help you perform electrical u t c



MEGA
KILO
BASIC UNIT
MILLI
MICRO
NANO
PICO
10^6
10^3
10^0
10^{-3}
10^{-6}
10^{-9}
10^{-12}
M
k
*
m
μ
n
p
MOVE DECIMAL POINT TO LEFT
MOVE DECIMAL POINT TO RIGHT

Perform the following electrical unit conversions. Record your in the space provided, and in the answer box.

1. 27,000,000 ohms is the same as ___ megaohms. 1. ☐
2. 1 kilovolt is the same as ___ volts. 2. ☐
3. 2,000 milliamperes is the same as ___ amperes. 3. ☐
4. .1 megaohms is the same as ___ ohms. 4. ☐

Name: 3

Date: ____________

Period: ____________

5.	9 amperes is the same as ________ milliamperes.	5.	
6.	600 millivolts is the same as ________ volts.	6.	
7.	250 microamperes is the same as ________ amperes.	7.	
8.	850 microvolts is the same as ________ milli volts.	8.	
9.	.115 amperes is the same as ________ milliamperes.	9.	
10.	60 kilohms is the same as ________ megaohms.	10.	
11.	90 ohms is the same as ________ kilohms.	11.	
12.	49,000 picoamperes is the same as ________ microamperes.	12.	
13.	5,000 microvolts is the same as ________ volts.	13.	
14.	6 kilohms is the same as ________ ohms.	14.	
15.	.75 volts is the same as ________ microvolts.	15.	
16.	Convert 350,000Ω to kΩ.	16.	
17.	Convert .005A to mA.	17.	
18.	Convert .000061V to µV.	18.	
19.	Convert 485,000V to mV.	19.	
20.	Convert 75kΩ to Ω.	20.	
21.	Convert 153mA to µA.	21.	
22.	Convert 62pV to mV.	22.	
23.	Convert 560Ω to kΩ .	23.	
24.	Convert 150µA to A.	24.	
25.	Convert .09V to kV.	25.	

SCORE:

GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

WORKSHEET

QUEST ACTIVITY

"UNIT 20"

REVIEW OF BASIC MATHEMATICAL SKILLS

Do all work in the spaces provided. Show your work on this paper. Record your answers in the answer boxes.

1.

$$\begin{array}{r} 15 \\ 28 \\ 37 \\ +\ 47 \\ \hline \end{array}$$

2. $2.27 + .84 + 390 =$

1. ☐

2. ☐

3. $8 + 8.8 + 88 + .8 =$

4. The sum of x and y can be written as:

A) xy

B) $\frac{x}{y}$

C) $x-y$

D) $x + y$

E) none of these

3. ☐

4. ☐

5.

$$\begin{array}{r} 8\ 9\ 7\ 6 \\ -\ 4\ 7\ 3\ 5 \\ \hline \end{array}$$

6.

$$\begin{array}{r} 4\ 8\ 3\ 7 \\ -\ 2\ 5\ 4\ 8 \\ \hline \end{array}$$

5. ☐

6. ☐

7. $4.8 - 3.27 =$

8. Find the difference between 632 and 425.78.

7. ☐

8. ☐

Name: ________ K

Date: ________

Period: ________

9. $\begin{array}{r} 73 \\ \times\ 61 \\ \hline \end{array}$

10. $\begin{array}{r} 2.08 \\ \times\ 2.3 \\ \hline \end{array}$

11. $\begin{array}{r} .3429 \\ \times\ 1000 \\ \hline \end{array}$

9. ☐
10. ☐
11. ☐

12. Which one of the following statements is true?

A) 6 x 4 = 21, B) 6 x 0 = 6, C) .6 x .4 = 2.4
D) 6 x 4 = 4 x 6, E) 6 x 4 = .24

12. ☐

In problems 13 - 16 write any remainders as fractions.

13. $\overline{)11095}$

14. 8416÷8

15. $\frac{9612}{27}$

13. ☐
14. ☐
15. ☐

16. In the division, $6\overset{7}{\overline{)42}}$, the number 7 is called the:

A) divisor, B) dividend, C) quotient,
D) remainder, E) none of these.

16. ☐

17. $3\overline{)1.69}$

18. $.018\overline{)3.6}$

19. $.44\overline{)11}$

17. ☐
18. ☐
19. ☐

20. Which of the following cannot be done?

A) 32 ÷ 0, B) 0 ÷ 14, C) $27\overline{)0}$, D) $\frac{0}{7}$, E) all of these.

20. ☐

Name: ____________

Date: ____________

Period: ____________

**In problems 21 - 28 reduce all fractions to lowest terms.

21. $\frac{1}{8} + \frac{1}{4} + \frac{3}{8} =$

22. $1\frac{1}{16} + \frac{3}{64} + 4\frac{17}{32} =$

23. $\frac{19}{64} - \frac{7}{32} =$

24. $19 - 2\frac{25}{64} =$

25. $\frac{2}{3} \times \frac{5}{8} =$

26. $1\frac{1}{4} \times 3\frac{1}{8} =$

27. $\frac{1}{8} \div \frac{3}{4} =$

28. $3\frac{2}{32} \div 1\frac{5}{64} =$

29. 4^3

30. $\sqrt{169}$

21. ☐
22. ☐
23. ☐
24. ☐
25. ☐
26. ☐
27. ☐
28. ☐
29. ☐
30. ☐

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

SCIENTIFIC NOTATION

Scientific notation is an easy, "short cut" method for expressing very large or very small numbers containing many zeros to either the right or left of the decimal point. Numbers such as 100,000,000 or .0000000025 can be easily shortened by writing them in scientific notation form. When multiplying or dividing with numbers containing many zeros, it is often difficult to keep track of the zeros and decimal points in order to arrive at a correct answer - scientific notation can help solve these types of problems too.

Let's look at an example of the "power" of scientific notation.

Try this problem:

15,000,000 X 6,200,000,000 = ?

If you used the standard multiplication method, your computations probably looked like this:

```
       6200000000
     x   15000000
     ------------
       0000000000
      0000000000
     0000000000
    0000000000
   0000000000
  0000000000
31000000000
6200000000
-----------------
93000000000000000
```

But, using scientific notation, your problem would look like this:

$$\begin{array}{l} 6.2 \times 10^{9} \\ \underline{1.5 \times 10^{7}} \\ \\ 310 \\ \underline{62} \\ 9.30 \times 10^{16} \qquad \text{OR} \qquad 9.3 \times 10^{16} \end{array}$$

As you can see, scientific notation uses powers of 10 to replace the zeros in the "regular" number. Study the charts below, and see if you can find the relationship between the exponent of 10, and the decimal number.

Name: ____________

Date: ____________

Period: ______ ______

POSITIVE POWERS OF 10	NEGATIVE POWERS OF 10
$10^0 = 1$	$10^0 = 1$
$10^1 = 10$	$10^{-1} = .1$
$10^2 = 100$	$10^{-2} = .01$
$10^3 = 1{,}000$	$10^{-3} = .001$
$10^4 = 10{,}000$	$10^{-4} = .0001$
$10^5 = 100{,}000$	$10^{-5} = .00001$
$10^6 = 1{,}000{,}000$	$10^{-6} = .000001$

- You probably discovered that the exponent indicates how many places move the decimal point. When using a positive power, the decimal p moved to the right, while using a negative power will move the deci point to the left.

Let's translate this knowledge into understanding scientific notati

- Scientific notation, in proper form, uses a number between 1 and 9. times a power of 10 as shown below:

$$\underset{\uparrow\atop\text{Number between 1 and 9.999...}}{\underline{2.5}} \times \underset{\nwarrow\atop\text{Times a power of 10}}{\underline{10^3}}$$

***** CONVERTING SCIENTIFIC NOTATION INTO "REGULAR" NUMBERS

Using your knowledge of powers of ten it should be fairly simple t translate scientific notation into a "regular" number. For exampl 2.5×10^3 is the same as 2500. Recall 10^3 means move the decimal places to the right.

Rules:

(Scientific notation to a "regular" number)

1. If the scientific notation expression has a po exponent, move the decimal point to the right same number of places as the exponent.

Example:

$3 \times 10^4 = 3$ or 30000

BEST COPY AVAILABLE

Name: ________________

Date: ________________

Period: ________________

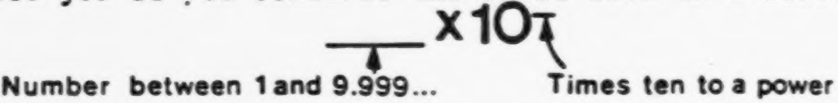
2. If the scientific notation expression has a negative exponent, move the decimal point to the left the same number of places as the exponent.

Example:

$2.1 \times 10^{-3} = .\underbrace{\quad 2}.1$ or .0021

*CONVERTING REGULAR NUMBERS INTO SCIENTIFIC NOTATION EXPRESSIONS

Converting a number such as 61000 into scientific notation is a fairly simple job if you remember the basic form of a scientific notation number:



That is, a number between 1 and 9.999... times ten to a power (the power can be either positive or negative).

● Thus, when converting to scientific notation, move the decimal point of the original number until you get a number between 1 and 9.999.... Count the number of places you moved the decimal - this number will be your exponent.

$61000.$

$6.\underbrace{1000}.$

$\underline{6.1} \times 10^4$

1) Begin at the decimal point.

2) Move decimal point to here, (number between 1 and 9.999...) and count places moved.

3) Write in scientific notation form. (Drop extra zeros; exponent is equal to the number of decimal places moved).

Rules:

("Regular" number to scientific notation)

1. If the original number is greater than 1, then move the decimal point to the left until you have a number between 1 and 10. The exponent of ten is equal to the number of places the decimal point is moved and is given a positive sign.

Example: Convert 5600 to scientific notation

$5600 = 5.\underbrace{600}. = \underline{5.6 \times 10^3}$

Name: ______

Date: ______

Period: ______

2. If the original number is less than 1, then move decimal point to the right until you have a numbe between 1 and 10. The exponent of ten is equal t the number of places the decimal point is moved a given a negative sign.

Example: Convert .00034 to scientific notation.

$.00034 = \underbrace{0003}.4 = \underline{3.4 \times 10^{-4}}$

*MULTIPLICATION USING SCIENTIFIC NOTATION

Using scientific notation when multiplying or dividing greatly simpl the job since you do not have to keep track of zeros or the number decimal places; plus its easy.

Look at this example and see if you can catch what is being done:

$$\begin{array}{r} 4 \times 10^{3} \\ \underline{\times\ 2 \times 10^{4}} \\ 8 \times 10^{7} \end{array}$$

- That's it - to multiply using scientific notation simply multiply th "numbers" together and add the exponents. (Watch the signs of the exponents).

Here are some other examples:

A)	B)	C)
3×10^{4}	2×10^{-2}	4.1×10^{-6}
$\times\ 7 \times 10^{-3}$	$\times\ 8 \times 10^{-1}$	$\times\ 5 \times 10^{4}$
21×10^{1}	16×10^{-3}	20.5×10^{-2}
OR	OR	OR
(2.1×10^{2})	(1.6×10^{-2})	(2.05×10^{-1})

*DIVISION USING SCIENTIFIC NOTATION

Dividing using scientific notation is almost as simple. See if you figure out the system by studying this example.

$$\frac{8 \times 10^{5}}{2 \times 10^{2}} = 4 \times 10^{3}$$

Name: ____________________

Date: ____________________

Period: ____________________

Did you understand that one? To divide, write the expressions as a fraction. Divide the numbers as you normally would, then change the sign of the exponent on the bottom, and add it to the exponent on the top.

Here are some more examples:

A) $$\frac{15 \times 10^{6}}{3 \times 10^{4}} = \boxed{\frac{15}{3}} = 5 \times \boxed{\begin{array}{r} +6 \\ -4 \\ \hline 10^{2} \end{array}} = 5 \times 10^{2}$$

B) $$\frac{14 \times 10^{-3}}{7 \times 10^{2}} = \boxed{\frac{14}{7}} = 2 \times \boxed{\begin{array}{r} -3 \\ -2 \\ \hline 10^{-5} \end{array}} = 2 \times 10^{-5}$$

C) $$\frac{25 \times 10^{1}}{5 \times 10^{-3}} = \boxed{\frac{25}{5}} = 5 \times \boxed{\begin{array}{r} 1 \\ +3 \\ \hline 10^{4} \end{array}} = 5 \times 10^{4}$$

D) $$\frac{36 \times 10^{-4}}{4 \times 10^{-2}} = \boxed{\frac{36}{4}} = 9 \times \boxed{\begin{array}{r} -4 \\ +2 \\ \hline 10^{-2} \end{array}} = 9 \times 10^{-2}$$

Simple!

Name: ____________________

Date: ____________________

Period: ________________

INFORMATIONAL HANDOUT

CONVERSION OF ELECTRICAL UNITS

There are six common prefixes or subunits used with electrical measurements. These units, (mega, kilo, milli, micro, nano, and pico) provide a simple method for expressing very large or very small numbers without having to use scientific notation. Study the chart below and learn the meaning and relationship between the various units.

PREFIX	ABBREVIATION	POWER OF 10 EQUIVALENT	NUMBERICAL VALUE
Mega	M	10^6	1,000,000
Kilo	k	10^3	1,000
Basic Unit (volts, amps, ohms, etc.)		10^0	1
Milli	m	10^{-3}	.001
Micro	μ	10^{-6}	.000001
Nano	n	10^{-9}	.000000001
Pico	p	10^{-12}	.000000000001

Thus; 1M is equal to 1×10^6 or 1,000,000.

2kV is the same as 2×10^3V or 2,000V.

3mA can be written as 3×10^{-3}A or .003A.

4μV is equal to 4×10^{-6}V or .000004V.

5nA is the same as 5×10^{-9}A or .000000005A.

6pV can be written as 6×10^{-12}V or .000000000006V.

Often times it is necessary to convert from one electrical unit to another, especially when working with basic electrical formulas which require the electrical quantities to be in basic unit, or similar units (all in milli, micro, etc.).

Name: ____________________

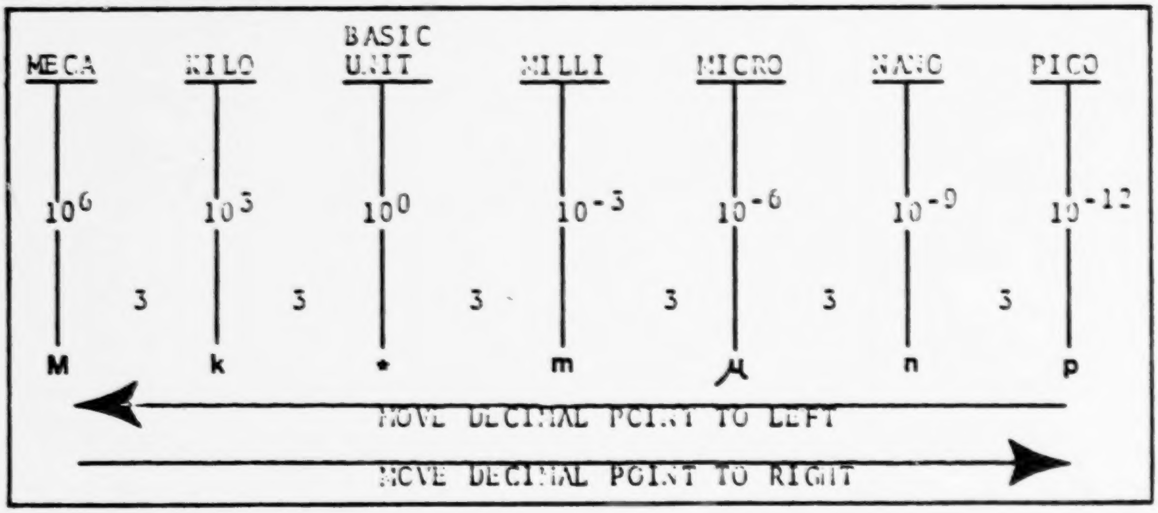
Date: ____________________

Period: ____________________

How would you convert 3kV to basic unit, or volts? Well, if you recall that kilo means thousand or 10^3, then it's easy to see that 3kV = 3 x 10^3 volts or 3000V. So actually, all that was done to convert from kilo to base was to move the decimal point 3 places to the right (3kV = 3‿‿‿. = 3000V). Likewise, if you are asked to change 3000V to kilo volts, all that need be done is to move the decimal point 3 places to the left. (3000V = 3.‿‿‿ = 3kV).
Thus, the process of converting from one electrical unit to another simply involves moving the decimal point to the left or to the right a certain number of places.

The chart below can be used as an aid in performing electrical unit conversions. Notice that between each unit there are three decimal places.

CONVERSION CHART:



Steps in using the conversion chart:

When converting from one unit to another:

1) Count the number of decimal places from the "original" unit to the "desired" unit. (Remember, there are 3 decimal places between each unit).

2) Determine the direction the decimal point will move. The decimal point will be moved in the same direction that you read across the chart, from your original unit to your final unit. For example, if you are converting from kilo to milli the decimal point will be moved to the right, but if you were converting from micro to basic unit the decimal point will be moved to the left.

3) **Move the decimal point the number of places counted in step 1, and in the direction determined in step 2.**

Name: ____________________

Date: ____________________

Period: ____________________

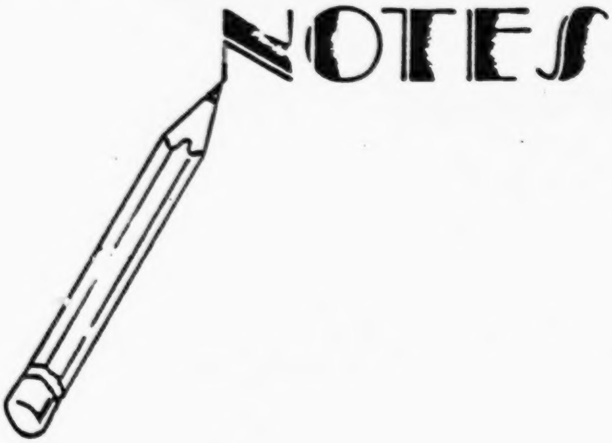
SAMPLE CONVERSIONS:

A. "25000 ohms is the same as __________ kilohms."
The question is asking you to convert 25000 ohms (basic unit) to kilohms (kilo). Looking at the chart; count the number of decimal places between basic unit and kilo. You should have come up with 3 decimal places. When counting, you started at "basic unit", and moved to kilo, which took you to the left across the chart; thus, you will move the decimal point to the left. With this information let's complete the conversion - - -

$25000\Omega = 25\underbrace{,000,} = \underline{25\text{k}\Omega}$

B. "Convert .007A to __________ mA"
Procedure: Move from basic unit (A) to milli which is 3 places to the right across the chart. Thus: $.007\text{A} = \underbrace{,007,} = \underline{7\text{mA}}$.

C. "Convert 4.3μV to __________ kV"
Procedure: Move from μ to k across the chart, which is 9 decimal places to the left. Thus: $4.3\mu\text{V} = \underbrace{,000000004,}3 = \underline{.0000000043\text{kV}}$.



Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

INTRODUCTION TO MATHEMATICAL FORMULAS

$$y = \frac{10 + z}{A}$$

The statement above is a mathematical formula. It tells how to obtain a desired result from a mixture of numbers and terms.

- You might think of a formula as a mathematical recipe. That is, by properly combining different ingredients together (numbers, operations, or variables) you will arrive at the desired result - a correct answer.

- A formula then, tells you what to do -- a mathematical formula tells you for example, when to add, subtract, multiply or divide.

Formulas can be simple statements such as $y = 10 + 6$ (which means to find the value of y, add 10 and 6) or very complex expressions such as $R = 7A^2 + 6A - 10$ (meaning to find the value of R; first square the value of A, multiply that by 7, add the result to 6 times A, and finally subtract 10).

- Whether a formula is simple or complex they have many things in common:

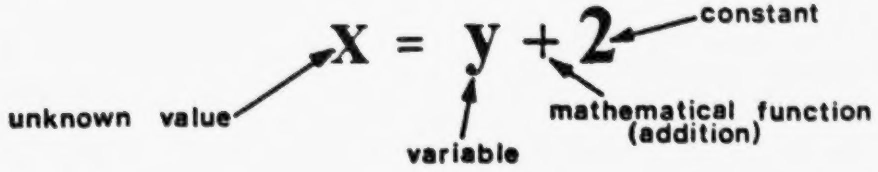
1) Unknown value: Generally abbreviated with a letter, and located by itself on the left side of the equal sign. This is the value you are trying to find.

2) Variable: A number, also abbreviated as a letter, but located on the right side of the equal sign. A variable can be assigned many different values.

3) Constant: A number with a fixed value.

4) Mathematical Function: The mathematical operation to be performed, such as multiplication, division, addition, or subtraction.

EXAMPLE:



Name: ____________________

Date: ____________________

Period: ____________________

USING MATHEMATICAL FORMULAS:

Study the sample problems below, they will explain how to use a simple formula.

1. Solve for "R" in the formula below, given that $y = 6$.

$\underline{\underline{R = 4 + y}}$	Step 1. Substitute the "given" value of y into the formula.
$R = 4 + \underline{6}$	
	Step 2. Perform the mathematical function - addition.
$R = 10$	
	Step 3. Record the solution.
$R = \boxed{10}$	

2. Solve for "Q" in the formula below, given that $S = 10$ and $D = 5$.

$\underline{\underline{Q = 2 \times S + D}}$	Step 1. Substitute the given values of "S" and "D" into the formula.
$Q = 2 \times \underline{10} + \underline{5}$	
	Step 2. Perform the multiplication.
$Q = 20 + 5$	Step 3. Perform the addition.
$Q = 25$	
	Step 4. Record the solution.
$Q = \boxed{25}$	

*Try this one on your own.

3. Solve for "E" in the formula below, given that $I = 5$ and $R = 100$.

$\underline{\underline{E = I \times R}}$	Step 1. ____________________
$E =$	____________________
$E =$	____________________
$E = \boxed{}$	Step 2. ____________________
	____________________
	____________________
	Step 3. ____________________
	____________________
	____________________

ANSWER: $\overline{005}$

5

Electronics A
METRIC PREFIXES

PREFIX	SYMBOL	POWER OF 10	VALUE	EXAMPLE
Tera	T	10^{12}	1,000,000,000,000	2THz = 2 x 10^{12} Hz
Giga *	G	10^{9}	1,000,000,000	9GHz = 9 x 10^{9} Hz
Mega *	M	10^{6}	1,000,000	5MHz = 5 x 10^{6}
Kilo *	K	10^{3}	1,000	9KV = 9 x 10^{3} V
Hecto	h	10^{2}	100	9hm = 8 x 10^{2} m
deka	da	10^{1}	10	6dam = 6 x 10^{1} m
deci	d	10^{-1}	0.1	7dm = 7 x 10^{-1} m
centi	c	10^{-2}	.01	4cm = 4 x 10^{-2} m
milli *	m	10^{-3}	.001	8mA = 8 x 10^{-3} A
mirco *	u	10^{-6}	.000001	5uW = 5 x 10^{-6} W
nano *	n	10^{-9}	.000000001	3ns = 3 x 10^{-9} s
pico *	p	10^{-12}	.000000000001	5pF = 5 x 10^{-12} F

* most commonly used in Electronics

Electronics A

Multiply Powers of 10

	Power of 10	Engineering Notation
1. $(2 \times 10^{2}) \times (3 \times 10^{4})$		
2. $(4 \times 10) \times (2 \times 10)$		
3. $(7 \times 10^{7}) \times (1 \times 10)$		
4. $(3 \times 10^{7}) \times (2 \times 10^{8})$		
5. $(5 \times 10^{5}) \times (1 \times 10^{2})$		
6. $(3 \times 10^{3}) \times (2 \times 10^{2})$		
7. $(7 \times 10^{2}) \times (1 \times 10^{2})$		
8. $(2.5 \times 10^{4}) \times (2 \times 10^{4})$		
9. $(2 \times 10^{-2}) \times (3 \times 10^{-4})$		
10. $(4 \times 10^{-1}) \times (2 \times 10^{-1})$		
11. $(7 \times 10^{-7}) \times (1 \times 10^{-1})$		
12. $(3 \times 10^{-7}) \times (2 \times 10^{-8})$		
13. $(5 \times 10^{-5}) \times (1 \times 10^{-2})$		
14. $(3 \times 10^{-3}) \times (2 \times 10^{-2})$		
15. $(7 \times 10^{-2}) \times (1 \times 10^{-2})$		
16. $(2.5 \times 10^{-4}) \times (2 \times 10^{-4})$		

7

Electronics A

Divide Using Powers of 10.

	Power Of 10	Engineering Notation
1. $(8 \times 10^{8}) \div (2 \times 10^{2})$		
2. $(9 \times 10^{9}) \div (3 \times 10^{3})$		
3. $(7 \times 10^{18}) \div (2 \times 10^{15})$		
4. $(6 \times 10^{6}) \div (4 \times 10^{4})$		
5. $(5 \times 10^{5}) \div (2 \times 10^{2})$		
6. $(8 \times 10^{8}) \div (2 \times 10^{2})$		
7. $(7 \times 10^{7}) \div (1 \times 10^{5})$		
8. $(6 \times 10^{12}) \div (3 \times 10^{3})$		
9. $(1 \times 10^{8}) \div (1 \times 10^{6})$		
10. $(1 \times 10^{6}) \div (1 \times 10^{8})$		
11. $(1 \times 10^{6}) \div (1 \times 10^{-8})$		
12. $(1 \times 10^{-6}) \div (1 \times 10^{8})$		
13. $(1 \times 10^{-6}) \div (1 \times 10^{-8})$		
14. $60{,}000 \div 200$		
15. $50{,}000 \div 0.002$		
16. $0.000\,016 \div 8 \times 10^{3}$		

8

CONVERSION PROBLEMS

GIVEN: CONVERT TO BASIC UNITS: CONVERT TO POWER OF 10:

1. 3 milliamperes ____________ amperes ____________ amperes

2. 7 kilovolts ____________ volts ____________ volts

3. 29 milliamperes ____________ amperes ____________ amperes

4. 62 millivolts ____________ volts ____________ volts

5. 45 kilocycles ____________ cycles ____________ cycles

****

6. 842 milliamperes ____________ amperes ____________ amperes

7. 24 millivolts ____________ volts ____________ volts

8. 224 millivolts ____________ volts ____________ volts

9. 551 kilocycles ____________ cycles ____________ cycles

. 147 kilovolts ____________ volts ____________ volts

****

11. 2.2 megohms ____________ ohms ____________ ohms

12. 1.53 megacycles ____________ cycles ____________ cycles

13. 67 microamperes ____________ amperes ____________ amperes

14. 3 microamperes ____________ amperes ____________ amperes

15. 472 microfarads ____________ farads ____________ farads

****

16. 7 picofarads ____________ farads ____________ farads

17. 29 picofarads ____________ farads ____________ farads

18. 380 picofarads ____________ farads ____________ farads

19. 33 megohms ____________ ohms ____________ ohms

. 14.3 megacycles ____________ cycles ____________ cycles

7

Electronics A
Powers of Ten and Scientific Notation

Express these numbers in powers of ten and scientific notation.

EXAMPLE: 2200 = 2.2×10^3 = 2.2K

1. 4700 = ________ = ________
2. 680 = ________ = ________
3. 1500000 = ________ = ________
4. 540000 = ________ = ________
5. 455000 = ________ = ________
6. 0.001 = ________ = ________
7. 0.000005 = ________ = ________
8. 0.000000047 = ________ = ________
9. 0.000250 = ________ = ________
10. 0.050 = ________ = ________

Express these numbers in powers of ten and the original number.

EXAMPLE: 15mA = 1.5×10^{-2} = .015

11. 2.5G = ________ = ________
12. 6.8K = ________ = ________
13. 1.55M = ________ = ________
14. 2K = ________ = ________
15. 5m = ________ = ________
16. 12p = ________ = ________
17. 47n = ________ = ________
18. 22u = ________ = ________
19. 25m = ________ = ________
20. 1u = ________ = ________

Express these numbers in scientific notation and the original number.

EXAMPLE: 6.8×10^3 = 6.8K = 6800

21. 25×10^2 = ________ = ________
22. 5×10^6 = ________ = ________
23. 47×10^4 = ________ = ________
24. 12×10^{-3} = ________ = ________
25. 22×10^{-12} = ________ = ________
26. 20×10^{-9} = ________ = ________
27. $.5 \times 10^{-2}$ = ________ = ________
28. 17×10^{-4} = ________ = ________
29. 47×10^{-3} = ________ = ________
30. 22×10^{-5} = ________ = ________

10

Work Sheet

POWERS OF TENS FOR NEGATIVE NUMBERS (less than one)

$.1 = 1.0 \times 10^{-1}$

$.01 = 1.0 \times 10^{-2}$

$.001 = 1.0 \times 10^{-3}$ = milli or 1m

$.0001 = 1.0 \times 10^{-4} = 100 \times 10^{-6}$ = 100 micro = 100u

$.00001 = 1.0 \times 10^{-5} = 10 \times 10^{-6}$ = 10 micro = 10u

$.000001 = 1.0 \times 10^{-6}$ = 1 micro or 1u

$.0000001 = 1.0 \times 10^{-7}$ = 100 nano or 100n

$.00000001 = 1.0 \times 10^{-8}$ = 10 nano or 10n

$.000000001 = 1.0 \times 10^{-9}$ = 1 nano or 1n

EXPRESS THE FOLLOWING NUMBERS IN SCIENTIFIC NOTATION AND ENGINEERING NOTATION

Example: $.00001 = 1.0 \times 10^{-5}$ or 10×10^{-6} or 10 micro

1. .0015 = ____________________ or ____________________ or ____________________
2. .109 = ____________________ or ____________________ or ____________________
3. .0000456 = ____________________ or ____________________ or ____________________
4. .000000002 = ____________________ or ____________________ or ____________________
5. .033 amps = ____________________ or ____________________ or ____________________
6. .00000097 = ____________________ or ____________________ or ____________________
7. 1 milli = .0____________________ or ____________________ or ____________________
8. 150 pico = .0____________________ or ____________________ or ____________________
9. 62 nano = .0____________________ or ____________________ or ____________________
10. .000000000010 = ____________________ or ____________________ or ____________________

TO ENTER POWERS OF TEN OR NEGATIVE EXPONENTS IN TO YOUR CALCULATOR, DO THE FOLLOWING

1. Enter number on keyboard as a number between one and ten. ($1^*.^*5^*$) = 1.5
2. Press the EE key. Display should look like this 1.5 00
3. Enter power of ten (EXPONENT) 3^* display is now 1.5 03
4. Press change sign key (+/-) display is now 1.5 -03 = 1.5×10^{-3}

UNIT EXAM

INTRODUCTION TO ELECTRONIC MATH FUNDAMENTALS

IMPORTANT-

Indicate your responses in the answer box only. Fill in the box corresponding to the correct answer to each question. There is only one correct answer for each question.

1. The abbreviation for milli is m. (T - F)

2. 100 kilovolt is grater than 1 megavolt. (T - F)

3. 1.5×5^{10} is a scientific notation expression. (T - F)

4. The electrical units volts, amperes, or ohms, are considered basic or base units. (T - F)

5. One microvolt is equivalent to .000001 volts. (T - F)

6. The expression $X = 10 + y^2$ is a mathematical formula. (T - F)

7. When converting from kilo to base, you should move the decimal point 3 places to the left. (T - F)

8. When multiplying numbers written in scientific notation, you should add the exponents together. (T - F)

9. The electrical units milli, micro, mega, and pico represent numbers less than zero. (T - F)

10. Pico has a power of ten equivalent of 10^{-9}. (T - F)

Convert the following scientific notation expressions to "regular"

11. $4.57 \times 10^2 =$ ____________________

12. $7.3 \times 10^{-3} =$ ____________________

13. $2.5 \times 10^0 =$ ____________________

Convert the following "regular" numbers into scientific notation. (Use proper form).

14. 560000 = ______________________

15. .0089 = ______________________

16. 555 = ______________________

Solve the following problems:

17. $$\begin{array}{r} 1.4 \times 10^{6} \\ \underline{\times\ 8.9 \times 10^{-3}} \end{array}$$

18. $$\frac{6.5 \times 10^{7}}{5 \times 10^{-3}}$$

Perform the following conversions.

19. Convert 2500 ohms to kilohms. ______________________

20. Convert .005 amps to milliamps. ______________________

21. Convert 450 microvolts to volts. ______________________

22. Convert 8900 picoamps to microamps. ______________________

23. Convert .6 megaohms to ohms. ______________________

24. Convert 20 millivolts to volts. ______________________

25. Given the formula: ⟶ $y = \frac{A \times B}{5}$

Solve for y if A = 5 and B = 15.

y = ____________________________________

TEST # ____

ELECTRONICS TECHNOLOGY

DO NOT WRITE ON THIS TEST. IF THIS TEST IS WRITTEN ON YOU WILL LOOSE FIVE (5) POINTS FROM THE FINAL SCORE. Be sure that you put the test number on your answer sheet.

1. How many watts in 8.6 KW?

   a. .0086W b. 8600W c. 860000W d. none of these

2, How many KHz in 1.68MHz?

   a. .00168 b. 1680 c. 1,680,000 d. .00000168

3. A current of .005A represents how many mA?

   a. .000005 b. .005 c. 5 d. 500

4. Metric prefix for 10^{-3} would be:

   a. m b. μ c. n d. p

5. Metric prefix for 10^{-6} would be:

   a. m b. μ c. n d. p

6. The number of 6×10^{3} would be equal to:

   a. .006K b. .6K c. 6K d. 600K

7. If you were to multiply $(6 \times 10^{6}) \times (4 \times 10^{5})$, what do you do with the exponents?

   a. Add b. Subtract c. Divide d. Multiply

8. If you were to divide $(3 \times 10^{4}) \div (3 \times 10^{-2})$, what would you do with the exponents?

9. Convert .0006 A to mA.

   a. .0000006 b. .0006 c. .6 d. 600

10. Convert .06nA to pA

    a. .00006 b. .06 c. 600 d. 60

For questions 11 through 15, convert the following to Scientific Notation.

11. 8,400,000

12. .0125

13. 16

14. .00360

15. .000,000,000,007,5

For questions 16 through 20, convert the numbers to proper numbers.

16. .034 X 10^4

17. 17.50 X 10^3

18. .012 X 10^{-4}

19. 850 X 10^2

20. .00047 X 10^6

For questions 21 through 30, convert the following units to the requested units.

21. .03A to mA

22. 2.48A to μA

23. 35mA to μA

24. 17.5KV to mV

25. 250 pH to μH

26. .0038mΩ to Ω

27. 165mH to μH

28. .004 to KΩ

29. 3843KHz to MHz

30. .3V to mV

Tên ______________________

Ngày ______________________

Thời điểm ______________________

SCIENTIFIC NOTATION

TECNICAL GLOSSARY

(NGỮ VỰNG KỸ THUẬT .)

BASIC UNIT : Đơn vị căn bản	Giá trị căn bản hay giá trị tổng của một số hoặc số đo điện : Được viết tắt hoặc tiếp đầu ngữ Thí dụ: volts, ohms và Amperes là các đơn vị căn bản (basic units). Trong khi millivolts, microamps hay kilohms không là các đơn vị căn bản. 3 Kohms có thể được phát biểu như một số 3000 ohms nó là một giá trị căn bản.
CONVERSION : sự biến đổi	Phương pháp thay đổi một số sự phát biểu từ một hình thức thành một hình thức khác tương đương. Thí dụ: biến đổi số 5000 thành Ký hiệu khoa học (scientific notation): 5×10^{3}.
DECIMAL POINT: chấm thập phân	Một chấm hoặc một điểm mà nó tách biệt số từ phần số thập phân. Vị trí của chấm thập phân thiết lập giá trị của số. 57.25 437.5 không bằng 43.75. chấm thập phân
EXPONENT : số mũ	Một số được đặt ở bên phải vào trên cao hơn một số khác. Số mũ (exponent) thì thường được gọi là số lũy thừa (power) và nó chỉ bao nhiêu lần số ấy tự nhân với chính nó. Thí dụ: 6^{4} ↖ số mũ (exponent) có nghĩa là $6 \times 6 \times 6 \times 6 = 1296$.
FORMULE : công thức	Một qui tắc toán học hoặc cách viết trong hình thức đẳng thức hay câu toán mà nó chứa đựng một dấu bằng (=) giữa giá trị được biết và giá trị chưa biết. Thí dụ. $E = I \times R$ là một công thức được đặt nghĩa tìm giá trị của E bằng cách nhân I với R.

Uu

until

up

us

use

used

22.

Gg

gave
get
getting
girl
girls
give
go
goes
going
good
got
great
green
grow

7.

KILO : Một đầu ngữ có nghĩa 1000 (một ngàn). Viết tắt K.
Ký lô
Thí dụ: 15 K có nghĩa 15,000.

MEGA : Một đầu ngữ có nghĩa 1,000,000 (một triệu) viết tắt
(mê ga)
là M. Thí dụ: 5M có nghĩa 5,000,000.

MICRO : Một đầu ngữ có nghĩa .000001 (phần triệu) viết
(maicrô)
tắt µ (muy). Thí dụ: 6µ có nghĩa .000,006.

MILLI : Một đầu ngữ có nghĩa .001 (phần ngàn) viết
(miu li)
tắt m. Thí dụ: 3m có nghĩa .003.

NANO : Một đầu ngữ có nghĩa .000,000,001 (phần tỷ)
(na-nô)
viết tắt là n. Thí dụ: 8n có nghĩa .000,000,008.

PICO : Một đầu ngữ có nghĩa .000,000,000,001 (1 phần
(pai cô)
triệu triệu) viết tắt p. Thí dụ: 4p có nghĩa .000,000,000,004.

POWER OF TEN: Một số mũ hoặc số lũy thừa của số 10. Nó có thể
(số lũy thừa của 10)
dùng để viết tắt các số như 1,000,000 (10^6) hay .000001 (10^{-6})

sự phát biểu số mũ của 10

PREFIX : Một chữ về mét hệ hay chữ viết tắt đặt trước đơn
(Tiếp đầu ngữ)
vị về điện và được dùng như một kiểu rút ngắn trong sự phát biểu những giá trị về số. Có 5 tiếp đầu ngữ về điện thông thường là mega, kilo, milli, micro và pico. Thí dụ:

7 KV thì bằng 7000 V.

tiếp đầu ngữ (prefix)

đơn vị điện (electrical unit)

SCIENTIFIC NOTATION : Một cách phát biểu cho các số rất to hoặc rất nhỏ
(ký hiệu khoa học)
bằng cách dùng một số giữa 1 và 9.999... nhân với một số mũ của 10. Thí dụ: 2.4×10^5 thì tương đương với số 240,000

HÃY NHỚ NHỮNG KÝ HIỆU NÀY:

mega = M
Kilo = k
basic unit *
milli = m
micro = μ
nano = n
pico = p

INFORMATION HANDOUT

SCIENTIFIC NOTATION

Scientific notation là một cách tính dễ dàng, cách rút ngắn nhanh lẹ các số rất lớn hay rất nhỏ mà những số đó chứa đựng nhiều số không "zeros" ở bên phải hay bên trái của dấu chấm thập phân (decimal point). Những số như là 100,000,000. hay .0000000025 thì dễ dàng viết rút gọn bằng hình thức ký hiệu khoa học (Scientific notation form).

Khi nhân hay chia với những số chứa đựng nhiều số zeros, nó thường khó giữ các số zero và dấu chấm thập phân để đưa tới kết quả chính xác - scientific notation có thể giúp giải quyết các bài toán này nữa.

Hãy quan sát tại một thí dụ "số mũ" của ký hiệu khoa học.

Hãy cố gắng với bài toán này:

15,000,000 x 6,200,000,000 = ?

Nếu anh (chị) dùng phương pháp tiêu chuẩn phép nhân, sự tính toán của anh (chị) giống như cách giải này:

```
       6200000000
       x 15000000
       ----------
       0000000000
      0000000000
     0000000000
    0000000000
   0000000000
  0000000000
 31000000000
6200000000
-----------------
93000000000000000
```

NHƯNG, dùng ký hiệu khoa học, vấn đề của anh chị giải quyết giống như thế này:

$$\begin{array}{l} 6.2 \times 10^{9} \\ \underline{1.5 \times 10^{7}} \\ 310 \\ \underline{62} \\ 9.30 \times 10^{16} \end{array} \quad \text{hay} \quad 9.3 \times 10^{16}$$

- Như Anh (chị) thấy, scientific notation dùng số mũ của 10 để thay thế cho các số zero trong số qui tắc "regular" number. Hãy học cách tính dưới đây, và thấy được nếu anh (chị) tìm sự liên quan giữa số mũ của 10, và số thập phân.

POSITIVE POWERS OF 10 (lũy thừa dương của 10)			**NEGATIVE POWERS OF 10** (lũy thừa âm của 10)		
10^0	=	1	10^0	=	1
10^1	=	10	10^{-1}	=	.1
10^2	=	100	10^{-2}	=	.01
10^3	=	1,000	10^{-3}	=	.001
10^4	=	10,000	10^{-4}	=	.0001
10^5	=	100,000	10^{-5}	=	.00001
10^6	=	1,000,000	10^{-6}	=	.000001

- Có thể anh (chị) đã tìm thấy rằng số mũ chỉ bao nhiêu vị trí để di chuyển điểm thập phân (dấu chấm). Khi dùng một số mũ dương, dấu chấm thập phân được dời về phía tay phải, trong khi đó khi dùng đến số mũ âm sẽ dời dấu chấm thập phân về phía tay trái.

  Hãy chuyển vận điều hiểu biết này vào trong sự hiểu biết ký hiệu khoa học.

- trong hình thức riêng, ký hiệu khoa học, dùng một số giữa **1** và **9.999...** nhân với **lũy thừa** của **10** như sự chỉ dưới đây:

$$\underbrace{2.5}_{\text{Số giữa 1 và 9.999}} \times \underbrace{10^3}_{\text{Nhân với số lũy thừa của 10}}$$

✱ CONVERTING REGULAR NUMBERS INTO SCIENTIFIC NOTATION EXPRESSIONS

(sự biến đổi chính số ra KÝ HIỆU KHOA HỌC)

Sự biến đổi một số như là 61000 ra ký hiệu khoa học là một việc làm khá đơn giản nếu anh (chị) nhớ hình thức căn bản của một số scientific notation.

$$\underline{\qquad\qquad\qquad} \times 10^{\uparrow}$$

số giữa 1 và 9.999...↑.

số lần đổi với một số mũ.

Đó là một số giữa 1 và 9.999... số lần 10 đổi với một số mũ (số mũ có thể hoặc dương hoặc âm).

● Như vậy, khi biến đổi vào scientific notation, hãy di chuyển chấm thập phân của số nguyên cho đến khi anh (chị) lấy một số giữa 1 và 9.999... Hãy đếm số vị trí mà anh (chị) để di chuyển phần thập phân – số này sẽ là số luỹ thừa của anh (chị).

$$61000.$$

$$6.\underbrace{1000}_{4\;\;3\;\;2\;\;1}.$$

di chuyển chấm thập phân từ phải sang trái rồi đếm 1-2-3-4 như vậy 4 là số luỹ thừa của 10.

$$\underline{6.1} \times 10^4$$

Cách thức hành

1.- Bắt đầu tại chấm thập phân.

2.- Di chuyển chấm thập phân từ đây. (số giữa 1 và 9.999...) và đếm vị trí đã di chuyển.

3- Hãy viết hình thức ký hiệu khoa học (Bỏ các số zero thừa; số luỹ thừa thì bằng số lần di chuyển chấm thập phân).

✱ CONVERTING SCIENTIFIC NOTATION INTO "REGULAR" NUMBERS :

(sự biến đổi ký hiệu khoa học ra các CHÍNH SỐ.

Hãy dùng sự hiểu biết về số mũ của 10 nó trở nên khá đơn giản để biến đổi từ ký hiệu khoa học ra một chính số (Regular number). Thí dụ : 2.5×10^3 thì bằng 2500 . Gọi lại 10^3 (đọc là 10 lũy thừa 3) có nghĩa là dời thập phân 3 vị trí về tay phải.

Rules: (SCIENTIFIC NOTATION TO A "REGULAR" NUMBER)

QUI - TẮC

1. Nếu scientific notation được phát biểu có số **lũy thừa dương**, di chuyển CHẤM THẬP-PHÂN về hướng **TAY PHẢI** bằng số vị trí được chỉ ở **lũy thừa dương**.

Thí dụ:

$$3. \times 10^{4} = 3\underbrace{\quad\quad\quad}_{\longrightarrow\ \underline{1}\ \underline{2}\ \underline{3}\ \underline{4}}. \text{ hay } 30000.$$

Chỉ sự di chuyển của dấu chấm thập phân 4 vị trí bằng số **lũy thừa** 4 của 10.

Rồi thêm số zero vào các vị trí đó có nghĩa $3\underset{1}{\underline{0}}\underset{2}{\underline{0}}\underset{3}{\underline{0}}\underset{4}{\underline{0}}.$

2. Nếu scientific notation được phát biểu có số **lũy thừa âm**, di chuyển CHẤM THẬP PHÂN về hướng **TAY TRÁI** bằng số vị trí được chỉ ở **lũy thừa âm**.

Thí dụ : $2.1 \times 10^{-3} = .\underbrace{\quad\quad}_{\longleftarrow}2.1$ hay .0021

Rules: (QUI-TẮC)

(Regular number to scientific notation)

1. Nếu số nguyên (original number) lớn hơn 1, khi di chuyển chấm thập phân về bên tay trái cho đến khi anh (chị) có một số giữa 1 và 10. Số lũy thừa của 10 thì bằng số vị trí chấm thập phân đã di chuyển và cho một số lũy thừa dương.

Thí dụ: Biến đổi 5600 ra scientific notation.

$$5600 = 5_{\wedge}\underbrace{\underbrace{600}_{\underline{3}\;\underline{2}\;\underline{1}}}_{\text{Số lũy thừa là 3}} = \underline{5.6 \times 10^{3}}$$

2. Nếu số nguyên nhỏ hơn 1, khi di chuyển về bên tay phải cho đến khi anh (chị) có một số giữa 1 và 10. Số lũy thừa của 10 thì bằng số vị trí chấm thập phân đã di chuyển và cho một số lũy thừa âm.

Thí dụ: Biến đổi .00034 ra scientific notation.

$$.00034 = \underbrace{\underbrace{0003}_{\underline{1}\;\underline{2}\;\underline{3}\;\underline{4}}}_{\text{Số lũy thừa là }-4}{}_{\wedge}4 = \underline{3.4 \times 10^{-4}}$$

✱ MULTIPLICATION USING SCIENTIFIC NOTATION

(TÍNH NHÂN DÙNG KÝ HIỆU KHOA HỌC)

Sự dùng scientific notation khi nhân hoặc chia những số nguyên đơn giản không có các số zero hoặc sự đặt chấm thập phân; việc dễ dàng của nó là cộng lại.

Thí dụ: Hãy nhìn thí dụ này và thấy được nếu anh (chị) có thể bắt lấy nó đang làm gì.

$$\begin{array}{r} 4 \times 10^{3} \\ \times\ 2 \times 10^{4} \\ \hline 8 \times 10^{7} \end{array}$$

- Đó là phép nhân dùng scientific notation, nhân đơn giản các số với nhau và cộng số lũy thừa. (Hãy nhìn những dấu hiệu của các số mũ).

Đây là một vài thí dụ:

A)
$$\begin{array}{r} 3 \times 10^{4} \\ \times\ 7 \times 10^{-3} \\ \hline 21 \times 10^{1} \end{array}$$
hay
(2.1×10^{2})

B)
$$\begin{array}{r} 2 \times 10^{-2} \\ \times\ 8 \times 10^{-1} \\ \hline 16 \times 10^{-3} \end{array}$$
hay
(1.6×10^{-2})

c)
$$\begin{array}{r} 4.1 \times 10^{-6} \\ \times\ 5 \times 10^{4} \\ \hline 20.5 \times 10^{-2} \end{array}$$
Hay
(2.05×10^{-1})

DIVISION USING SCIENTIFIC NOTATION

(TÍNH CHIA DÙNG KHÍ HIỆU KHOA HỌC)

Tính chia dùng ký hiệu khoa học thì hầu hết là đơn giản. Hãy quan sát nếu anh (chị) có thể đưa con số ra ngoài hệ thống bằng cách học thí dụ này.

$$\frac{8 \times 10^{5}}{2 \times 10^{2}} = 4 \times 10^{3}$$

Anh (chị) đã hiểu thí dụ trên chưa? Việc chia, Hãy viết các phần toán như một phân số. Hãy chia các số thường, rồi đổi dấu số mũ ở dưới đáy, và cộng nó với số mũ ở trên đỉnh của phân số.

Đây là một vài thí dụ:

A) $$\frac{15 \times 10^{6}}{3 \times 10^{4}} = \boxed{\frac{15}{3}} = 5 \times \boxed{10^{\begin{array}{r}6\\ \underline{-4}\\ 2\end{array}}} = 5 \times 10^{2}$$

B) $$\frac{14 \times 10^{-3}}{7 \times 10^{2}} = \boxed{\frac{14}{7}} = 2 \times \boxed{\overset{\begin{smallmatrix}-3\\ \underline{-2}\end{smallmatrix}}{10^{-5}}} = 2 \times 10^{-5}$$

c) $$\frac{25 \times 10^{1}}{5 \times 10^{-3}} = \boxed{\frac{25}{5}} = 5 \times \boxed{\overset{\begin{smallmatrix}1\\ \underline{+3}\end{smallmatrix}}{10^{4}}} = 5 \times 10^{4}$$

D) $$\frac{36 \times 10^{-4}}{4 \quad 10^{-2}} = \boxed{\frac{36}{4}} = 9 \times \boxed{\overset{\begin{smallmatrix}-4\\ \underline{+2}\end{smallmatrix}}{10^{-2}}} = 9 \times 10^{-2}$$

Simple!

L11 - U20 - 20 BIS

INFORMATIONAL HANDOUT
(CHỈ DẪN CẬP NHẬT)

CONVERSION OF ELECTRICAL UNITS
(SỰ BIẾN ĐỔI CÁC ĐƠN VỊ ĐIỆN)

Có 6 đầu ngữ chung hay các chữ bắt buộc được dùng với số đo của điện. Những đơn vị này là:
(Mega, kilo; milli, micro, nano và pico)
Chúng được cung cấp một phương pháp giản dị cho sự phát biểu các số rất lớn hoặc rất nhỏ ngoài sự dùng scientific notation. Hãy học biểu đồ dưới đây và am hiểu nghĩa những quan hệ giữa các đơn vị đổi khác.

PREFIX (đầu ngữ)	ABBREVIATION (sự viết tắt)	power of ten equavelent (lũy thừa 10)	NUMBERICAL VALUE (giá trị bằng số)
Mega	M	10^6	1,000,000
Kilo	k	10^3	1,000

Basic unit (VOLTS, AMPERES, OHMS, etc.) 10^0 1

milli	m	10^{-3}	.001
micro	μ	10^{-6}	.000001
nano	n	10^{-9}	.000000001
pico	p	10^{-12}	.000000000001

Như thế: 1M thì bằng 1×10^6 hay 1,000,000.
2KV thì bằng 2×10^3V hay 2,000V.
3mA thì bằng 3×10^{-3}A hay .003A.
4μV thì bằng 4×10^{-6}V hay .000004V.
5nA thì bằng 5×10^{-9}A hay .000000005A.
6pV thì bằng 6×10^{-12}V hay .000000000006V.

TECHNICAL GLOSSARY

(ngữ vựng kỹ thuật)

SOLVE	giải quyết	EXPLAIN	cắt nghĩa
ABBREVIATE	viết tắt	MATHEMATICAL	về toán
convert	biến đổi	statement	sự phát biểu
formula	công thức	obtain	lấy, nhận được
Rule	Qui-tắc	result	kết quả, đáp số
Basic unit	Đơn vị căn bản	mixture	sự hỗn hợp
similar	tương tự	terms	.chữ (về điện) .Từ ngữ
equal	bằng		
actual	thực, có thực	properly	riêng, riêng biệt
point	chấm (.)	combine	kết hợp
certain	chắc chắn	combining	sự kết hợp.
decimal	Thập phân	different	Khác
chart	biểu đồ	difference	Sự khác nhau
desired	-kiểu, thể, - mong muốn.	ingredient	phần tử, thành phần
Determine	xác định	together	cùng nhau, với nhau
direction	Trực tiếp		
information	sự chỉ dẫn	operate	chạy máy, làm
proceduce	cách làm	operation	sự chạy máy
Thus	Như thế, như vậy	correct	đúng
complete	hoàn thành	variable	có thể thay đổi
between	ở giữa, giữa	unknown value	giá trị chưa biết
mathematical	Function: dấu hiệu về toán (+ hay - ...)	constant	chưa đúng, số mà cố định

substitute	Thay thế	reduce	đơn giản
perform	thiết lập, thi hành	lowest	gần nhất, Thấp nhất.
Record the solution	thu nghiệm số		
multiplication	phép nhân	problem	bài toán, vấn đề
addition	phép cộng	Review	ôn lại
devision	phép chia	Skill	Tài khéo
subtraction	phép trừ	answer	trả lời
fixed value	giá trị cố định	answer boxes	ô trả lời
final	Kết thúc	In the division	trong phép chia
recipe	cách thức	power = exponent	Số mũ, Số lũy thừa
expression	từ ngữ	probably	có thể
operation	phân tách, làm	proper form	hình thức thích đáng
subtract	trừ đi	Recall	nhớ lại
unscramble	xếp lại	regular number	chính số
uncover	tạo thành	original number	Số nguyên
scrambled	được trộn lẫn	indicated	được chỉ
puzzle	nan giải	Drop extra zeros	bỏ thừa số zero.
divisor	số chia	computation	sự tính toán
dividend	số bị chia	compute	tính
quotient	số thương	standard	tiêu chuẩn
remainder	dư số	Relationship	quan hệ (n)
none of these	không phải các cái này.	establishes	thiết lập
fraction	phân số	separate	tách ra
The sum of	Tổng số	fundamental	căn bản.
product	Tích số		

LII-U20-6

數学应用(USING MATHEMATICS)

技術語彙

基本單位(單元)(BASIC UNIT)：以沒有缩写或字首写出的一個數目的總值或測得的电器數值. 如：伏特(volts)，歐姆(ohms)及安培(amps or amperes)均為基本單元. 而千分之一伏特(millivolt) 百萬分之一安培(microamps)或千歐姆(Kilohm)等则不是基本單元. 3 kilom = 3 k ohm 能以 3000 ohm(歐姆)来表示出其基本單元。

轉換(CONVERSION)：将原本表示的型式轉变為相当的他种型式的方法，例如将 5000 轉換為 5×10^3 之科学記示(scientific notation)

小數点(DECIMAL POINT)=将小數内的整數分开来的"点"謂之。小數点的位置确定數目的大小。

如 57.25 决不等於 5.725，437.5 並不等於 43.75。

小數点

指數(EXPONENT)：位於數目右上角的數值. 指數通常被称為"次方"(power)以表示該數值自己相乘多少次。

例如 6^4 即表示 6 乘自己 4 次 $= 6 \times 6 \times 6 \times 6 = 1296$

指數

公式(FORMULA)：一种數学定则(定律)或方式以等號("=")表示出来或用數学句式在已知數與未知數之间用等號連結。

例如：$E = I \times R$ 此公式表達 I、R 是已知數，E 是未知數 则如何地以 I 值乘 R 值而求得 E 值.

千(KILO)：千(1,000)的字首結合詞(prefix). 缩写為：K

如：15K 即意 15,000.

(MEGA) 百萬：1,000,000 (百萬) 的字首结合詞，缩写為 M
例如：5M 即意 5,000,000

(MILLI) 千分之1 ： 0.001 (千分之一) 的字首结合詞. 缩写為 m.
如 3m 即意 0.003

(MICRO) 百萬分之1 ： 0,000001 (百萬分之一) 的字首结合詞. 缩写為 μ
如 6μ 即意 0.000006

(NANO) 十億分之一 ： 0,000000001 (十億分之一) 的字首结合詞. 缩写為 n. 如 8n 即意 0,000000008

(PICO) 十億分之一的千分之一 ： 0,000000000001 的字首结合詞. 缩写為 p. 如 4p 即意 0,000000000004.

十的次方 (POWER OF TEN) ： 10 (十) 這個數的自乘次數. 其可用来将數目缩短写出表達。如 1,000,000 即 10^6 或 .000001 即 10^{-6} 十的正(负)次方 (此為六次方).

字首结合詞 (PREFIX)：在电器單元前写出的公制缩写字母. 用以缩短數值的書写. 有五种通常用到的电器用語的字首结合詞. 如 mega, kilo, milli, micro, 及 pico.
例如 7KV 即意 7000V.
字首结合詞
电器語之基本單元

科學記示(數) (SCIENTIFIC NOTATION)：用數目由 1 至 9.99--- 之间的數目乘以 10 的次方以表達十分大的數值或十分小的數值。
例如：2.4×10^5 即意 240,000.
暗示：2.4 即是在 1 与 9.99---之间的數目，其再乘以 10 的 5 次方，科学記數即要在小數点前必須有一位數的整數，再乘十的幾正次方或负次方。

-13,-14,15.
LII-2120-8,-9.-10.-11.12,

unscramble：解讀[密碼]

uncover：暴露,顯出

numerical value：數目值

expression：表示,表现)

proper form：適当的形式.

regular number：正常一般表示數目的方法.

decimal point：小數点.

places：位數,位置.

multiplication：乘法

division：除法.

complete：完成

unit：單元

abbreviation：缩写

equivalent：等於.相等的.

chart：圖解,图表,

perform：履行、完成.

review：温習

basic：基礎的,基本的.

mathematical skill：數学計算技巧

difference：不同,差異.

statement：陳述,算式.

remainders：餘數.

fraction：分數

divisor：除數,(分數之分母)

dividend：被除數(分數之分子).

quotient：商

reduce：降低.

LII-U20-16

科学記數(記示)法

SCIENTIFIC NOTATION

科学記示法是一种很方便很快而容易地把在小數点前或後擁有許多零的很大的或很小的數值表示出来的方法。例如 100,000,000 或 .000000025 這類數目可以用科学記示法很短捷地表示。当做乘法或除法時這類擁有許多零的數目是很難把答案的小數点的位置放对，但科学記示法可以協助你決解這种问题。

讓我们来看個例子以了解此法之"神力".

问题如：　15,000,000 × 6,200,000,000 = ?

若你用一般標準算術計算方式来解，则你的計算很可能像：

```
          6200 000000
    ×       15 000000
    -----------------
          0000 000000
         00000 00000
        0000000000
       0000000000
      0000000000
     0000000000
    31000000000
   6200000000
-----------------------
   93 000000000000000
```

但若用科学記示法，则你的问题就变成：

```
    6.2×10^9
    1.5×10^7
  ------------
   31 0
   62
  -----------
   9.30 ×10^16     或 9.3×10^16
```

- 你可以看出，科学記示法是用 10 的次方 (power of 10) 来代替在普通數目 ("regular" number) 中的零 (zeros)、研讀下国表及找出 10 的<u>次方數值</u>与小數点位置之间的関係。

LII-U20-17

POSITIVE POWERS OF 10	NEGATIVE POWERS OF 10
$10^0 = 1$	$10^0 = 1$
$10^1 = 10$	$10^{-1} = .1$
$10^2 = 100$	$10^{-2} = .01$
$10^3 = 1,000$	$10^{-3} = .001$
$10^4 = 10,000$	$10^{-4} = .0001$
$10^5 = 100,000$	$10^{-5} = .00001$
$10^6 = 1,000,000$	$10^{-6} = .000001$

- 你可能已看出來,"次方"指出小數点移动的位置的次數。
  當用"正次方"(positive power),是小數点向右移位.
  當用"負次方"(negative power)是小數点向左移位

讓我们来詳细說明:

- 科学記數的正式形式是以1至9.999…之间的數字乘10的次方如下圖:

$$\underset{\text{Number between 1 and 9.999...}}{\underline{2.5}} \times \underset{\text{Times a power of 10}}{\underline{10^3}}$$

※ 科学記數轉換為"一般數字"(REGULAR NUMBERS)
利用你所了解的10的次方是很简單而正確地將科学記數轉換為一般數字. 例如: 2.5×10^3 即為 2500, 記住 10^3 即是小數点向右移位3次。

法則 (Rules):

1. 若科学記數有"正次方"表现出来,则將小數点向右移位,移位次數与次方數目相同
   如: $3 \times 10^4 = 3.\underbrace{}$ 即 30000.

2. 若科学記數有"負次方"表現出來,則將小數点向左移位,移位次數與次方數相同.

如: $2.1 \times 10^{-3} = \underbrace{.\;\;\;\;2}{}1$ 即 .0021

※ 一般數字轉換為科学記數

若你記得科学記數的基本形式,則很容易就將如61000的一般數字轉換了.

即.在1至9.99……之數乘10的次方(此次方可正,可負).

- 當轉換成科学記數時,將小數点移位直到你得到的數字是在1至9.99…之間.數一數小數点移位多少次.則就是10的次方的數目.

$61000.\uparrow$

$6\underbrace{.1000.}$

$\uparrow$

$\underline{6.1} \times 10^{4}$

1)由小數点開始

2).移动小數点至此位.
(此數在1至9.99…之間).
及數一數移位次數.

3).写成科学記數(劃去多餘的零,次方數目即移位數次。)

法則(Rules):

1. 若原来數字大於1.則將小數点向左移位直到你的數字在1與9.99…之間.其次方數目即移位之次數且是正數

如: 轉換 5600 為科学記數

$5600 = 5\underbrace{.600}. = \underline{\underline{5.6 \times 10^{3}}}$

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2. 若原數字小於1，則小數點向右移位直到得到的數字在1与9.99---之间，次方數即是移位之次數且為負數.

例如：轉換 .00034 為科学記數.

$$.00034 = \underbrace{000}3.4 = \underline{\underline{3.4\times10^{-4}}}$$

※ 科学記數的乘法.

用科学記數來原乘、除法減化了不必要的零及小數點位置的尋找.

見例：

$$\begin{array}{r} 4\times10^{3} \\ \times\ 2\times10^{4} \\ \hline 8\times10^{7} \end{array}$$

- 將科学記數的數目相乘而次方數相加即得.

見例.

A).
$$\begin{array}{r} 3\times10^{4} \\ \times\ 7\times10^{-3} \\ \hline 21\times10^{1} \end{array}$$
或
(2.1×10^{2})

B).
$$\begin{array}{r} 2\times10^{-2} \\ \times\ 8\times10^{-1} \\ \hline 16\times10^{-3} \end{array}$$
或
(1.6×10^{-2})

C).
$$\begin{array}{r} 4.1\times10^{-6} \\ \times\ 5\times10^{4} \\ \hline 20.5\times10^{-2} \end{array}$$
或
(2.05×10^{-1})

※ 科学記數的除法.

用科学記數來做除法也是很簡單的. 下例你可看出什麼原則嗎？

$$\frac{8\times10^{5}}{2\times10^{2}} = 4\times10^{3}$$

你了解嗎？先將其以分數形式表達. 用正常做除法的方法來除數字. 將分母的次方數改變符號与分子次方數相加.

見例：

LII-U20-20

A). $\frac{15\times10^{6}}{3\times10^{4}} = \boxed{\frac{15}{3}} = 5\times10^{\boxed{\begin{array}{r}+6\\-4\\\hline 2\end{array}}} = 5\times10^{2}$

B) $\frac{14\times10^{-3}}{7\times10^{2}} = \boxed{\frac{14}{7}} = 2\times10^{\boxed{\begin{array}{r}-3\\-2\\\hline -5\end{array}}} = 2\times10^{-5}$

C). $\frac{25\times10^{1}}{5\times10^{-3}} = \boxed{\frac{25}{5}} = 5\times10^{\boxed{\begin{array}{r}1\\+3\\\hline 4\end{array}}} = 5\times10^{4}$

D) $\frac{36\times10^{-4}}{4\times10^{-2}} = \boxed{\frac{36}{4}} = 9\times10^{\boxed{\begin{array}{r}-4\\+2\\\hline -2\end{array}}} = 9\times10^{-2}$

簡單吧!

CIZ-420-21, -22.

电器單位之轉換
(CONVERSION OF ELECTRICAL UNITS)

prefixes : 字首.

subunits : 副單位.

method : 方法

expressing : 表達 表示.

meaning : 含意

relationship : 関係

various : 不同的.

necessary : 必須

convert : 轉換

basic : 基本

formulas : 公式, 式.

require : 需要

quantities : 量. 數量.

similar : 相似的

recall : 回想. 回憶.

means : 意思是…….

actually : 事实上.

places : 位置.

decimal point : 小數点.

left : 左

right : 右

involves : 包含. 涉及.

conversion : 轉換

performing : 完成, 履行.

count : 數數目. 算一算.

original : 原来的

desired : 希望求的.

determine : 決定.

L22-U20-24-25.

direction : 方向

move : 移动.

數學公式之介紹

(INTRODUCTION TO MATHEMATICAL FORMULA)

statement : 記述, 聲明

mathematical : 數学的

result : 结果

recipe : 處方, 配方.

combining : 合, 併.

ingredients : 成份, 要素,

variables : 变數, 不定數.

add : 加(法) (addition)

subtract : 減(法) (subtraction)

multiply : 乘(法) (multiplication)

divide : 除(法) (division).

complex : 複雜.

unknown value : 未知數.

located : 置於---位.

abbreviated : 缩写.

constant : 常數, 不变之值.

mathematical function : 數学算法

"given" value : 已知數 (由題目中得知)

UNIT II

TITLE OF UNIT: History of Electronics

Time Allocation: 1 week

Unit Goal:

To impart basic knowledge and competencies related to the historical development of the Electricity/Electronics field and to assess the impact of these developments.

Overview:

This Unit is presented as a non-technical unit of instruction, however, there are many basic competencies that the student will acquire through their work.

The Unit should be introduced with a historical description of man's first experiences with electrical phenomena. Then briefly make reference to Thales's discovery and its relationship with the present day terminology. The instructor will than have to explain that for several hundred years very little significant electrical discoveries took place.

The unit should continue with a chronology of developments including historical figures, inventions and theories. This time frame of developments should conclude with a short description of "state of the art" technical discoveries of modern society.

This Unit ultimately is concerned in exposing the roots of this area, and giving credit to those who have planted the seeds of technology.

ELECTRONI URRICULUM

VOCATIONAL TRAININ ON PLAN **#II** History of Electroni

Teaching Materials Source ______________________________

Chapter ______________, pages ______________

Lab Manual pages ______________

Additional Instructor Materials ______________________________

Main concepts student will learn:

To impart basic knowledge and competencies related to the historical development of the Electricity/Electronics field and to assess the impact of these developments.

The student will be able to:

1. state the word origin of the terms electron, electrics, or electricity.
2. identify the most significant centuries in reference to electrics discoveries and their contribution to the overall field of Electricity/Electronics.
3. select five historical figures described in this unit and explain their specific invention and/or theory which has distinguished their life.

Technical Vocabulary

None

Related General Vocabulary

Teaching Activity

Lecture
Film

Length of Lesson

1 week

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

Materials and Notes

1. In addition to normal classroom activities, have students research a specific historical figure and develop a biographical sketch of the individuals life. If available use the school library, or if this is not practical the students may research their report utilizing an encyclopedia. Check whatever audio/visual resource system that is available for materials that could coordinate wtih this unit topic. Especially be on the look out for films pertaining to Edison, Bell, Faraday, Morse, and Ohm. Many of these historical film biographies are classics and well worth showing.
2. To emphasize the technological advancements that have occured, compare and contrast a simple crystal radio to a modern radio. Then, draw the schematic of a crystal radio on the board and in general terms explain how it functions. Ask a student to build a working model, and is the craftsmanship is super, mount the unit on a frame to be utilized as a demonstrator for future classes.
3. Check with the local telephone company and find out if they have some visual in reference to the development of the telephone.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Develop a short definition, using your own words, for the following terms.

1. ELECTRICITY:

2. ELECTRON:

3. ELECTRONICS:

4. AMBER:

5. STATIC ELECTRICITY:

6. DYNAMIC ELECTRICITY:

Name: ____________________

Date: ____________________

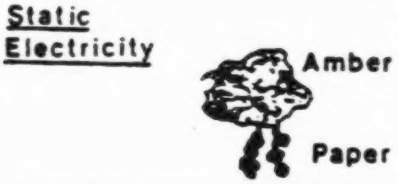
Period: ____________________

HISTORY

INFORMATIONAL HANDOUT

TIME LINE OF ELECTRONICS HISTORY

THE RECORD BEGINS IN GREECE:



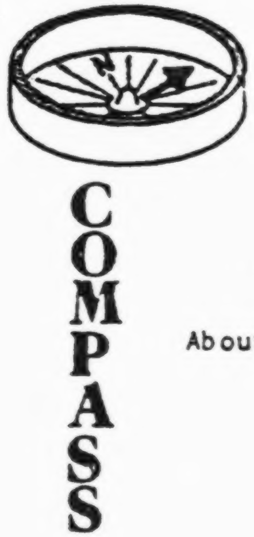
600 B.C.-- Thales, a statesman and philosopher discovered a curious attractive force between small bits of material, and a material called "elektron" (amber) that had been rubbed with cloth. Today we call this phenomenon static electricity.

SEVERAL HUNDRED YEARS LATER:

426 A.D.-- Saint Augustine distinguishes between electricity and magnetism.

ABOUT A THOUSAND YEARS PASS THEN:

1200 A.D.-- Compass first used for navigation by the Vikings. The crude device consisted of a piece of loadstone, placed on a small board, floating in a pail of water.



1600 A.D.-- William Gilbert, English physician to Queen Elizabeth discovered other materials that possessed similar properties as Thales elektron materials. He called these materials Electrics. Gilbert developed the electroscope, an instrument used for detecting an electrical charge. Gilbert's work was highlighted with the publication of the first scientific study of magnetism - "de magnete."

About 1660 A.D.-- Otto Von Guericke invented the first static electric generator - a machine which produced static electricity by friction between a rotating sulphur ball and the body.

1675 A.D.-- Sir Isaac Newton, in England, discovered electrostatic induction. The effect of static charges can be felt or transmitted over a distance.

THE EIGHTEENTH CENTURY - AGE OF BASIC DISCOVERIES:

1729 A.D.-- Stephen Gray distinguishes between conductors and insulators. He also makes the important discovery that electricity can be transmitted.

Name: ____________________

Date: ____________________

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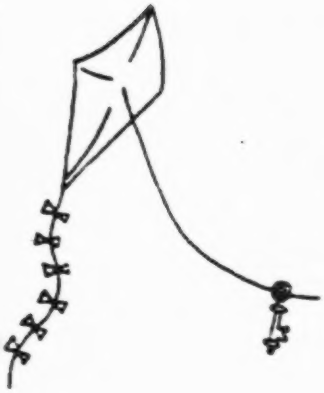
1733 A.D.-- Charles DuFay shows that there are two kinds of electricity which he called vitreous and resinous. Today we know these as positive and negative.

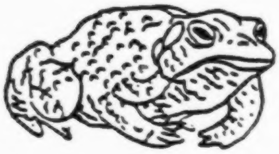


1745 A.D.-- E.G. von Kleist and Pieter Van Musschenbroek independently developed a device for storing electric charges - the "Leyden Jar." The Leyden Jar was the predecessor to the modern capacitor.

1746 A.D.-- Gralath built an electrometer, the first instrument for measuring electricity.

1752 A.D.-- In America, Ben Franklin performed his famous kite experiment to prove electricity and lightning are similar.

1785 A.D.-- Charles Coulomb, in France, proved the law of inverse squares in connection with electricity and magnetism.



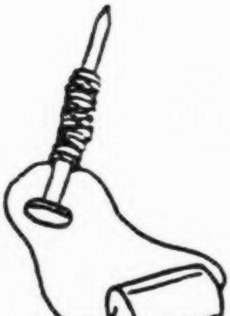
1786 A.D.-- Luigi Galvani noticed that frog legs contracted when touched by two connected dissimilar metals. This was the modest beginnir of the electric battery.

1799 A.D.-- Alessandro Volta, an Italian professor, develops the voltaic pile, the first primary battery.

THE NINETEENTH CENTURY - THE "GOLDEN AGE" OF ELECTRICAL INVENTION AND DISCOVERY

1820 A.D.-- Hans Christian Oersted (Denmark) discovered that an electric current deflects a suspended magnet.

-- Andre Ampere (France) demonstrated electromagnetic reaction.



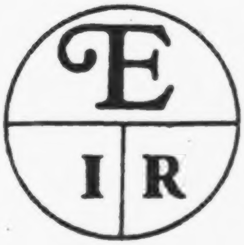
1821 A.D.-- England - Michael Faraday causes a current carrying conductor to rotate about a magnetic field. This laid the foundation for the electric motor.

1825 A.D.-- William Sturgeon (England) made the first electromagnet.

Name: ____________________

Date: ____________________

Period: ____________________



-- Georg Simon Ohm discovered that voltage, current, and resistance have a certain predictable interrelationship. Ohm's Law was presented - $E = I \times R$.

1831 A.D.-- Joseph Henry (U.S.A.) and Michael Faraday (England) independently discovered the phenomenon of electromagnetic induction and the generation of electricity by magnetism.

-- Faraday constructs a disc dynamo, the first electro-mechanical generator.

-- Henry discovers self-induction or inductor action.

1837 A.D.-- Samuel Morse (U.S.A.) invents the first practical telegraph.

1839 A.D.-- Karl Gauss (Germany) publishes his theory of magnetism and forces of attraction.

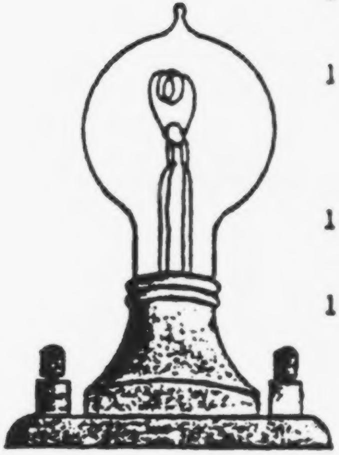
$$\begin{array}{r}1\\+1\\\hline 10\end{array}$$

1841 A.D.-- Arc lamps first demonstrated in Paris.

1847 A.D.-- George Boole establishes the foundation of modern computer operation in his "mathematica logic." Known today as Boolean Algebra.

1858 A.D.-- Faraday supervises the installation of dynamos used to power arc lights in English lighthouses.

1866 A.D.-- Cyrus Field lays the first successful trans-atlantic telegraph cable.



1873 A.D.-- James Maxwell (England) publishes his scientific paper on the theory of electromagnetic radiation. This formed the mathematical foundation for radio waves.

1876 A.D.-- Alexander Graham Bell (U.S.A.) develops the first practical telephone.

1879 A.D.-- Thomas A. Edison (U.S.A.) invents the carbon-filament lamp. First practical incandescent lamp.

-- Ernest W. Von Siemens (Germany) successfully demonstrated a three-car electric train.

1880 A.D.-- Edison installs electric street lighting in New York City.

Name: ____________________

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Period: ____________________

1883 A.D.-- Edison Discovers the Edison Effect, which formed the basis for vacuum tube discoveries.

1886 A.D.-- Heinrich Hertz (Germany) verified the mathematical predictions of Maxwell by producing electromagnetic waves, and thus opening the field of practical radio.

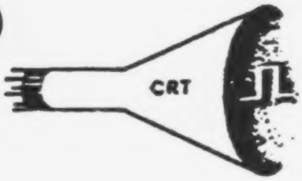
-- Edison patents carbon microphone.

-- Alternating current first used in America for a commercial lighting system.

1888 A.D.-- Nikola Tesla (U.S.A.) invents the AC induction motor. A company named Westinghouse manufactures it.

1892 A.D.-- General Electric Company formed.

1896 A.D.-- Italy - Guglielmo Marconi sent radio telegraph messages over a distance of 9 miles.



1897 A.D.-- Marconi demonstrates ship-to-shore wireless.

-- Karl Ferdinand Braun constructs first cathode ray oscilloscope.

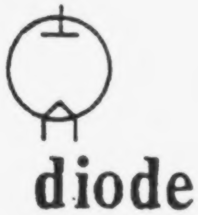
1899 A.D.-- Sound first recorded on magnetic wire.

1900 A.D.-- William Duddel discovers that an electric arc can be made to produce continuous oscillations This formed the basis for early spark-gap transmitters.

-- Prof. Reginald Fessenden first transmits speech by wireless.

1901 A.D.-- First transatlantic wireless message.

1903 A.D.-- Dr. Ernest Alexanderson builds first high-frequency alternator at General Electric which produced a 100 Khz wave.



1904 A.D.-- Prof. John Fleming patents a two-element thermionic device called the Fleming Valve based upon the Edison Effect. It was used to detect Hertzian waves and is known today as the diode tube.

THE VACUUM TUBE ERA (1905-1948):

1906 A.D.-- General Dunwoody develops the crystal detector which utilized carborundum to "detect" signals

5

Name: ____________________

Date: ____________________

Period: ____________________

triode

-- Dr. Lee de Forest (U.S.A.) adds a grid to the Fleming Valve producing the audion tube, a three element device which laid the foundation of modern electronics. The audion tube is known today as the triode tube.

1915 A.D.-- First transatlantic radio telegraphy communication from the United States.

1917 A.D.-- George Campbell develops the first electrical wave filter. Making possible communication "channels."

1920 A.D.-- KDKA Pittsburgh - the first broadcast radio station begins operation.

-- Edwin Armstrong designs the superheterodyne circuit - forerunner to modern radio receivers

1923 A.D.-- Dr. Vladimir Zworykin patents iconoscope TV camera tube.

TV

1925 A.D.-- TV demonstrated by John Baird in England.

1929 A.D.-- Dr. Vladimir Zworykin demonstrates the kinescope, the first "modern" picture tube.

1930 A.D.-- Col. W. Blair patents first basic radar system

1931 A.D.-- Oscilloscope produced by Allen DuMont.

1933 A.D.-- Karl Jansky discovers radio astronomy.

1937 A.D.-- Varian Brothers invent the Klystron tube - a high power microwave oscillator.

1938 A.D.-- William Hewlett and David Packard work to produce a diathermy machine for Stanford Hospital.

RADAR

1939 A.D.-- NBC demonstrates TV broadcast utilizing the new orthicon camera developed by RCA.

1941 A.D.-- Commercial FM broadcasting began in U.S.A. on January 1.

-- Commercial TV authorized by the FCC on July 1.

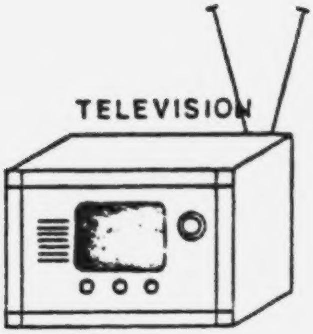
-- First military application of newly developed radio-detection device (radar) December 7, at Pearl Harbor.

1942 A.D.-- Magnetic recording tape developed.

Name: ____________________

Date: ____________________

Period: ____________________



1944 A.D.-- One of the first digital computers developed by Howard Aiken at Harvard University called the automatic-sequence-controlled calculator and was used extensively by the U.S. Navy.

-- V-beam radar introduced by MIT's radiation lab. - First practical do-everything radar.

1946 A.D.-- RCA introduces the first mass produced B&W television; model 630TS - 10 inch picture tube, sold for $375.

-- Eniac computer developed by Eckert and Mauchly at the University of Pennsylvania. Digital programmable machine, 5000 arithmetic calculations per second, weighed 30 tons, contained 18,000 vacuum tubes, and required 130KW of power. By todays standard Eniac was comparable to a basic hand held calculator.

-- RCA demonstrates the first "all electronic" color TV.

1947 A.D.-- Bell labs - December: the first signal am- fied by a semiconductor crystal is observe The work of John Bardeen, Walter Brattain, and William Shockley results in the Germanium Point-Contact Transistor.

THE TRANSISTOR ERA (1948-1959):

TRANSISTOR

1948 A.D.-- The transistor is born - the beginning of modern electronics.

1949 A.D.-- The record business is shattered; the 78 RPM is out. RCA introduces the 45 RPM disc, while CBS developed the 33-1/3 format.

1951 A.D.-- Univac I computer introduced by the Remington-Rand Corporation.

1952 A.D.-- RCA experiments with the first all transistorized television set.

-- Andrew Kay develops the first digital voltmeter at Non Linear Systems Company.

1953 A.D.-- H.J. Zeigler developes the beam maser - a device that could amplify microwave signals with light. This amplifier was the forerun r of the laser.

Name: ____________

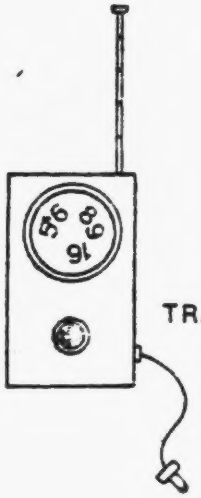
Date: ____________

Period: ____________

-- Tektronix introduces the concept of plug-in modules for test equipment.

1954 A.D.-- Bell labs perfects a method of growing single crystal silicon. This development laid the foundation for today's multibillion-dollar semiconductor industry.

-- Calvin Fuller of Bell labs developed the process of diffusing impurities into the surface of silicon wafers, paving the way for the development of the integrated circuit.


TRANSISTOR RADIO

-- Texas Instruments introduces the silicon transistor.

-- Daryl Chapin, Calvin Fuller, and Gerald Pearson at Bell labs develop the solar battery (cell).

-- First application of transistors to consumer products. Regency Company markets a four-transistor radio.

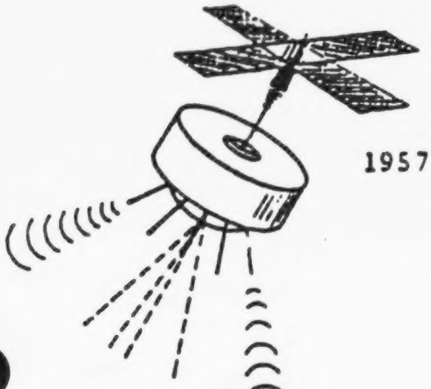
1955 A.D.-- Tappan introduces the microwave oven for home use.

Mucan Corporation and Bell labs develop the varacator diode then known as the voltage-variable capacitor, and used today for electronic tuning with no moving parts in TV's and radio's.

1956 A.D.-- Bell and Howell introduces the all-electronic movie camera.

-- Bell labs demonstrates the feasibility of the TV telephone.

-- GE commercialized the silicon-controlled rectifier (SCR).


satellite

1957 A.D.-- Russia launched Sputnik - the first man made orbital satellite.

-- Burroughs Corporation develops the first gas-discharge numerical readout tube - the nixie.

-- U. Gianola of Bell labs developed the plated wire memory. At IBM, large rotating discs were used for the first time to make a random access memory capable of storing up to five million characters.

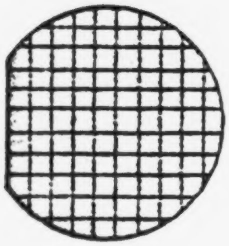
Name: ____________

Date: ____________

Period: ____________

-- RCA unveils a miniaturized FM transmitter small enough to be swallowed. Today's astronauts use modern versions of these pill trans mitters to send physical data back to earth.

1958 A.D.-- The first integrated circuit is developed by Jack Kilby at Texas Instruments. The crude circuit contained several transistors, a few resistors, and some capacitors. Today, a similar sized IC could contain ten thousand transistors. At about the same time, at Fairchild's Semiconductor Division, Dr. Robert Noyce developed a similar type of circuit in which all components were integrated or formed on a single chip of silicon.



Silicon Wafer

-- GE and Crystalonics introduces commercial field effect transistors (FET).

-- Stereo phonograph records begin to appear. A few radio stations begin to broadcast in stereo.

1959 A.D.-- RCA introduces the nuvistor, a thimble-sized vacuum tube which heralded the last attempts of tube manufacturers to compete against transistor devices.

THE INTEGRATED CIRCUIT ERA (1959-):

Light
AMPLIFICATION BY THE
Stimulated
EMISSION OF
Radiation

1960 A.D.-- Fairchild develops the planar process for the production of transistors and ICs. This process involves the evaporation of aluminum over the circuit to form conductors.

-- Texas Instruments offers first IC product line called the "solid circuit series 1" which consisted of simple logic circuits.

-- Bell labs develops the epitaxial process which allowed a crystal structure to be grown on a substraight or another crystal structure. This technique became the mainstay of transistor and IC fabrication.

1961 A.D.-- Laser devices developed by Hughes, Bell labs, Raytheon, and IBM.

1962 A.D.-- Solid-State laser developed at both GE and IBM research labs.

-- Signetics introduces diode-transistor logic.

Name: ______________________

Date: ______________________

Period: ______________________

LED

-- First light-emitting diodes (LEDs) developed, although they were not commercially available until 1968.

-- **Telestar** communications satellite launched on July 10, making possible satellite relayed communication via telephone and television.

1963 A.D.-- The first commercial mini-computer was introduced by Digital Equipment Corporation model PDP-5 used a 12 bit format, and contained 1K of memory. It sold for $27,000.

-- Sylvania introduces the first integrated circuits utilizing TTL logic, designated as Sylvania's universal high level logic.

1964 A.D.-- IBM introduces the system 360 computer series, intended to replace all existing IBM computer series.

-- Zenith produces one of the first consumer products which utilized integrated circuits, a hearing aid.

-- Texas Instruments introduces the 5400 series TTL logic series.

-- Fairchild introduces one of the first linear ICs - the 702 OP amp.

-- Dual-inline-package (DIP) first appears.

1966 A.D.-- Andrew Bobeck announces the development of magnet-bubble devices.

1968 A.D.-- RCA introduces a new IC technology - COS/MOS.

1969 A.D.-- July 20, Apollo 11 astronauts Armstrong and Aldrin land on the moon. The successful landing, and return to earth culminated a decade of break-throughs in electronics.

1970 A.D.-- Intel develops the first dynamic MOS random-access memory (RAM), a 1025-bit device. Prior to this development, computer memories utilized magnetic cores or semiconductors.

-- Mostek and TI show that all the logic for a four function calculator could be put on a single chip utilizing a technique known as MOS/LSI.

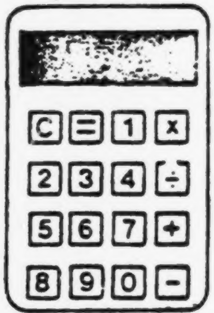
Name: ____________________

Date: ____________________

Period: ____________________

-- Harris Semiconductor introduces the PROM a new user-programmable memory..

-- Hamilton introduces the "Pulsar," an LED display wristwatch. Cost $2100.



calculator

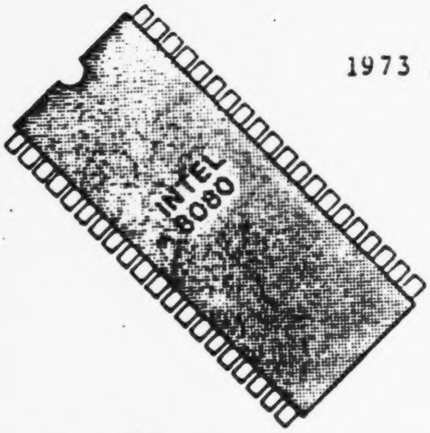
1971 A.D.-- Ted Hoff spearheads the development of the first microprocessor - Intel's 4004. Shortly thereafter the 8008 CPU chip is introduced.

-- Hand-held calculators make their debut. Simple 4 function units produced by Hewlett-Packard, Sharp, and Texas Instruments sold for $400.

1972 A.D.-- Liquid crystal displays offer a new technology for numerical displays, offering the advantage of low power consumption, and high visability in daylight conditions.

-- Microma Universal introduces the first commercial liquid crystal display wrist watches. Cost $150.

-- Magnavox markets the first Odyssey TV game units. Atari followed with Pong in 1976.



I.C.

1973 A.D.-- Intel upgrades the 8008 and introduces the 8080. National Semiconductor and Rockwell field their own microprocessor designs.

-- I^2L (integrated-injection logic) emerges due to the work of IBM and Philips. This new circuit technique allows high density, high operating speed, and low dissipation. The first I^2L products - a 4-bit microprocessor and a watch circuit - were introduced by Texas Instruments.

-- Advent introduces "Video Beam" projection TV.

1975 A.D.-- Home video tape recorder systems presented by AVCO (Cartivision), Sony (Betamax), and others.

-- Microprocessor based home computers begin to appear in the hobby and engineering market. The first units were sold in kit form by companies such as MITS (Altair), Sphere, IMSAI, and Southwest Technical Products. These first machines were generally 8080 or 6800 based. The machines became financially

Name: ____________________

Date: ____________________

Period: ____________________

Large SCALE Integration

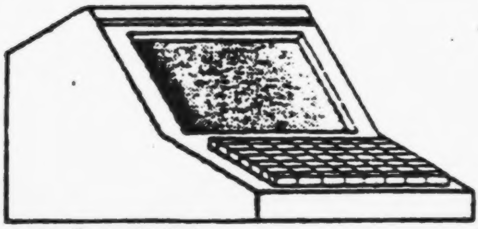
feasible due to the cost effective production of LSI chips which dropped the price of the original microprocessor chip from $200 to $20 each.

-- Ionization and optical smoke detectors introduced for home use.

1976 A.D.-- The body scanner, an x-ray type machine which is capable of analyzing the complete body for medical growths, tumors, bone problems, etc. is introduced by GE.

-- Breakerless electronic ignition systems become available as original equipment or add-on for automobiles.

1977 A.D.-- 40-channel CB radio approved by the FCC.



HOME COMPUTER

-- New generation of home computers emerge. These systems are pre-assembled, offer simplified programming techniques, and are comparitively low in cost. The Radio Shack TRS-80, Commodore PET, and Apple II are examples of this new breed.

-- The world's first optical (fiber-optic) communications system to provide regular telephone service was placed in operation by General Telephone Company. This feat culminated years of work in development and experimentation with optical fibers and appropriate light sources.

1978 A.D.-- New era microprocessor chips based upon 16 bit words instead of the more common 8 bit word length promise to deliver 10-times the performance of the industry-standard 8080 chip.

WHAT NEXT?

WORKSHEET - ELECTRONICS 1 Name ____________

ELECTRONIC HISTORY Shop #____Date________

Match the individuals or companies listed below with their discoveries, record the associated letter in the answer box and also identify the time period in which the discovery was made.

		Matching Letter	Time Period
1. Samuel Morse	A. Odyssey TV game	1______	______
2. KDKA Pittsburgh	B. Voltaic Pile	2______	______
3. CBS	C. Silicon Transistor	3______	______
4. Stephen Gray	D. Telephone	4______	______
5, MITS (Altair)	E. Oscilloscope	5______	______
6. Texas Instruments	F. Point-Contact Transistor	6______	______
7. George Boole	G. Apollo 11	7______	______
8. Thales	H. Telegraph	8______	______
9. Sony(Betamax)	I. Leyden Jar	9______	______
10. Tappan	J. Insulators & Conductors	10______	______
11. Hewlett-Packard	K. Diode Tube	11______	______
12. Alessandro Volta	L. Microwave Oven	12______	______

ELECTRONIC HISTORY 1 - Pg. 2

Name ____________________

				Matching Letter	Time Period
13.	Bell Labs	M.	Diode-Transistor Logic	13.______	______
14.	E. G. Von Kleist	N.	1st Broadcast Radio Station	14______	______
15.	Allen DuMont	O.	33 1/3 RPM Record	15______	______
16.	Intel	P.	Edison Effect	16______	______
17.	Thomas A. Edison	Q.	Fiber-Optic Communications	17______	______
18.	George Simon Ohm	R.	Hand Held Calculators	18______	______
19.	General Telephone Co.	S.	Microprocessor Kits	19______	______
20.	Magnavox	T.	Home Video Tape Recorder	20______	______
21.	Prof. John Fleming	U.	E = I x R	21______	______
22.	Armstrong & Aldrin	V.	Dynamic MOS RAM	22.______	______
23.	Signetics	W.	"Elecktron" (amber)	23______	______
24.	Alexander Graham Bell	X.	Boolean Algebra	24______	______
25.	RCA	Y.	Mass Production of B/W TV	25______	______

UNIT QUIZ

Match the historical individual with his/her discovery or invention.

1. Thales of Miletus
2. Stephen Gray
3. Alessandro Volta
4. Michael Faraday
5. Georg Simon Ohm
6. Samuel Morse
7. Alexander Graham Bell
8. Thomas Edison
9. Heinrich Hertz
10. Guglielmo Marconi
11. Dr. Lee de Forest
12. Col. William Blair
13. John Bardeen, Walter Barttain, and William Shockley
14. Jack Kilby
15. Ted Hoff

A. E I X R

B. Radar

C. Battery

D. Incandescent lamp

E. Integrated circuit

F. Static electricity

G. Audion tube

H. Telegraph

I. Electricity can be transmitted

J. Produced electromagnetic waves

K. Telephone

L. Transistor

M. Generator

N. Microprocessor

O. Wireless communication

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________
11. ____________
12. ____________
13. ____________
14. ____________
15. ____________

HiSTORY

TECHNICAL GLOSSARY

AWARE : biết
AWARENESS (n) sự biết
CLASSIFY (vt) xếp ra từng loại
classifying (n) -
Device : phương pháp, kế hoạch, bộ phận
Devise : sáng chế, dịch vụ
Electric, eletrical : về điện
Electricity : điện khí, điện học.
Electrode : điện cực
Control : điều khiển, kiểm soát.
stove : lỗ (suởi).
stereo system : hệ thống âm thanh.
Contribute : góp vào.
Assignment : cộng taó.
Appliance : đồ dùng, dụng cụ.
Essential : chính, nhất, quan trọng.
Existance : sự tồn tại, hiện có.

Luxury : lộng lẫy
Perhaps : Có lẽ, hoặc giả.
Influenced : ảnh hưởng.
Create : Tạo nên, sáng lập.
Be neat : gọn, ngăn nắp.
Machine : máy, cơ giới.
Recently (adv): vừa qua, Mới đây
Recent (a) -
Invent : phát minh.
Brownish-yellow: vàng nâu.
fossil (a & n) : hoá thạch
Amber , chất hổ phách (Vật thạch hoá màu vàng nâu)
Mysterious (n): bí hiểm.
Material : vật liệu.
phenomenon : hiện tượng
Static electricity : tĩnh điện.
Evolved : làm tiến hoá
Dynamic electricity: động lực điện.
Electron : âm điện tử.
Usable = useable: dùng được.

Functional	Công dụng.
Free electrons	Âm điện tử Tự do.
Friction	sự va chạm, cọ sát.
Induction	Cảm ứng
Reaction	Sự chống lại
React	chống lại
Identify	Nhận rõ, chỉ rõ.
Similar	đồng dạng, tương tự.
Manner	Kiểu
Behave	hành động.
Charge	điện tích (xạc điện)
Negative charge	điện tích âm.
Positive charge	điện tích dương
Electrical action	Hành động điện.
Especially	một cách đặc biệt
Circuit	Mạch điện
Resistor	điện trở
Resistance	cản điện
Transistor	bán dẫn, khuyếch đại.
Invention	Sự phát minh.
Historical development	sự phát triển lịch sử. (lịch sử phát triển)
Collection	Sự thu nhặt.
Electrical charges at rest	Các điện tích điện đứng nghỉ.
Discovered	~~Đã~~ khám phá.
Attractive force	Lực hút.
Distinguish	phân biệt.
Magnetism	từ tính (nam châm)
Compass	la bàn, địa bàn.
navigation	Sự giao thông trên đường thủy.
Consist	gồm có.
Crude	sống.
Loadstone	đá nam châm.
Float	nổi, phao nổi.
board	tấm ván, bo.
Floating in a pail of water	- nổi trong 1 thùng nước.

Pail	cái thùng.
English Physician	nhà vật lý học người Anh.
Possess (vt)	có
similar properties	Những bản chất tường tự.
Electroscope	Điện nghiệm.
Detecting	việc khám phá
Publication	sự công bố.
Sulphur	Chất lưu huỳnh
Static electric generator	Máy phát tỉnh điện.
Electro static induction	Sự cảm ứng tỉnh điện.
Effect	tác dụng.
Affect	ảnh hưởng.
Transmit	Truyền tống.
Conductor	Chất dẫn điện.
Vitreous → positive	⊕
Risinous → Ngative	⊖
Independently	một cách độc lập.
Predecessor	làm trước
Electrometer	Máy đo điện.
perform	Thi hành
lightning	chớp (sét)
Inverse	ngược lại.
frog	con ếch.
Contract	co lại
dissimilar	≠ similar.
Pile	pin điện.
Current	Cường độ.
Deflect	lệch.
Subspend	tạm, hoãn.
Magnet	Nam châm.
Demonstrate	chứng minh
Electromagnet	Nam châm điện.
Magnetic field	Từ trường
Telegraph	máy điện báo.
predict	đoán trước
predictable	có thể tiên đoán
Interrelationship	mối sự quan hệ.
Establish	thiết lập, dựng.
Foundation	Nền tảng, cơ sở, căn bản.
Computer	máy tính điện tử.

Install : lập, dựng

Installation (n) sự dựng nên.

Radio wave : sóng vô tuyến điện.

Incandescent lamp : (bóng) đèn tròn.

Vacuum tube : đèn chân không

Microphone : Máy vi âm.

Wire : dây điện, dây thép.

Wireless : Không dây.

Transatlantic: đi qua đại dương

Frequency : tần số

Diode : đèn lưỡng cực có 2 phần (âm cực và bản cực)

Grid -> Gridiron : vỉ sắt để nướng (thịt)

Audion tube : Đèn điện tử 3 cực.

Triode tube : Đèn chân không có 3 bộ phận là: âm cực, lưới cực và dương cực.

Communication : giao chuyển, Thông đạt.

Channels : Đài (Truyền hình)

Camera tube : Đèn thu hình (thu nhận và biến đổi hình ảnh thành tín hiệu điện)

Picture tube : Đèn hình, màn ảnh (screen).

Oscilloscope : Máy đo dao động (Dùng tia âm cực để quan sát tín hiệu).

Radar : Hệ thống truyền phát (Dùng tia năng lượng của một tần số và thời gian, nhờ âm dội để xác định vị trí khoản cách và sức lực của 1 vật ở xa mà không thấy được)

Semiconductor : chất bán dẫn (nửa dẫn điện nửa cách điện)

Amplifier : Khuyệt đại.

Laser : Tia sáng hồng ngoại tuyến (cũng gọi là tia cực tím)

Observer : quan sát

Industry : kỹ nghệ.

Crystal : ống vi âm tinh thể.

Introduce : giới thiệu
Microwave : vi ba
Develop : phát triển
Capacitor : Tụ điện
Feasibility : năng lực
Commercialized Thương mại hoá.
Silicon-Controlled-Rectifier (SCR): Bộ chỉnh lưu Silicon.
Orbital Satellite : Vệ tinh quay theo quỹ đạo.
Readout tube: đèn phóng âm.
Random : sự tình cờ
Miniature : thanh vẽ thu gọn.
phonograph : máy hát (dĩa)
(Biến chuyển từ sự rung động cơ khí phát ra từ kim chạy trên dĩa thành tín hiệu điện và được khuyếch đại qua loa Thành âm thanh).
Record : Thu lại.
Máy thu thanh
Appear : xuất hiện
Feasible : Có thể làm được
Detector : Máy dò
Available : Có ích, dùng được.

Automobile : xe cộ
Simplified : được thu gọn, rút gọn.
Comparitively : tính chất so sánh.
Compare : so sánh
Feat : công việc, tài nghệ
Culminate : lên tới chỗ cao nhất
Experiment : kinh nghiệm, thí nghiệm.
Experimentatim (n) sự thực nghiệm
Thí nghiệm ...
Optical : Quang học
Appropriate : Thích đáng, thích hợp.
Instead : Thay vì
perform : Thi hành
performance (n) việc thi hành
người thực hiện.
Sự thực hiện
hình thức thi hành.
Historical individual : lịch sử cá nhân.
Techno = skill : Tài khéo.

Tên : ____________
Ngày: ____________
Thời Điểm: ____________

TIME LINE OF ELECTRONIC
(Thời điểm lịch sử của ngành Điện tử)

TÀI LIỆU KHỞI ĐẦU TẠI HY-LẠP :

NĂM 600(Trước THIÊN-CHÚA):

Thales, Ông ta là một chánh trị gia vừa là triết gia dã khám phá ra là có một sức hút giữa hai vật nhỏ, trong dó một chất dã dược chà sát trên nỉ, chất này dược gọi tên là "elektron" (amber). Ngày nay, chúng ta gọi hiện tượng này là tĩnh-diện.

VÀI TRĂM NĂM SAU:

NĂM 426(Sau THIÊN-CHÚA):

Saint Augustine , phân biệt giữa diện và từ tính.

VÀ KHOẢNG HÀNG NGÀN NĂM SAU:

NĂM 1200(Sau THIÊN-CHÚA):

Đầu tiên Vikings dùng dịa bàn dể đi biển. Địa bàn này gồm có một miếng nam châm thiên nhiên (loadstone), dặt trên một mảnh ván nhỏ dược thả nổi trong một chậu nước.

NĂM 1600(Sau THIÊN-CHÚA):

William Gilbert, Bác sĩ riêng của nữ hoàng Elizabeth dã khám phá ra nhiều chất khác mà có tính chất tương tự những chất elektron (Elektron materials) của Thales. Ông gọi những chất này là ĐIỆN (Electric). Gilbert khai triển diện nghiệm (electroscope), một dụng cụ dùng dể khám phá một diện tích (electrical charge). Gilbert là người dầu tiên mở dầu cho khoa từ tính học- "de magnete.".

VÀO KHOẢNG NĂM 1660 (Sau THIÊN-CHÚA):

Otto Von Guericke phát minh ra máy phát tĩnh diện (static electric generator) dầu tiên- Máy phát tĩnh diện là máy sản xuất ra tĩnh diện do sự cọ xát giữa một trái banh quay bằng lưu hoàng(sulfur) và có thể.

NĂM 1675 (Sau THIÊN-CHÚA);

Ông Isaac Newton, ở Anh quốc, dã khám phá ra cảm ứng tĩnh diện (electrostatic induction). Ảnh hưởng tĩnh diện có thể nhận biết hoặc có thể truyền đi trên một khoảng cách ,

THẾ KỶ THỨ MƯỜI TÁM - THỜI ĐẠI CỦA NHỮNG KHÁM PHÁ CĂN BẢN :

NĂM 1729 (Sau THIÊN-CHÚA):

Stephen Gray phân biệt giữa những chất dẫn diện vã những chất cách diện. Ông cũng khám phá ra một diều quan trọng lã diện có thể truyền di dược.

NĂM 1733 (Sau THIÊN-CHÚA) :

Charles Dupay chứng tỏ rằng có hai loại diện mã ông ta gọi lã vitreous va resinous. Ngày nay , chúng ta gọi lã diện dương (positive) vã diện âm (negative).

NĂM 1745 (Sau THIÊN-CHÚA):

E.C von Kleist vã Pieyor Van Musschenbroek dã khuếch trương một dụng cụ để chứa những diện tích- "Bình-Leyden.". Bình Leyden lã tiền thân của bộ tụ diện (capacitor)hiện tại.

NĂM 1746 (Sau THIÊN-CHÚA) :

Gralath chế ra một diện kế (electrometer), một dụng cụ để do diện dầu tiên.

NAM 1752 (Sau THIÊN-CHÚA):

Ở Mỹ quốc, Ben Franklin dã lãm một con diều (kite) thí nghiệm để chứng minh rằng diện vã tia chớp (lightning) thì giống nhau.

NAM 1785 (Sau THIÊN-CHÚA):

Charles Coulomb, ở Pháp, dã chứng minh dịnh luật bình phương nghịch dảo (the law of inverse squares) trong mối quan hệ giữa diện tỉnh va tử tính.

NAM 1786 (Sau THIÊN-CHÚA):

Luigi Galvani nhận thấy rằng hai cái dùi của con ếch bị co rút lại khi tiếp xúc với hai kim khí khác nhau dược nối liền nhau. Diều nãy dã bắt dầu cho bình diện (electric battery) dờn só.

NĂM 1799 (Sau THIÊN-CHÚA):

Alessanddro Volta, một giáo sư người Ý, phát triển loại pin Volta, loại pin dầu tiên trên thế giới.

THẾ KỶ THỨ 19- THỜI ĐẠI "HOÀNG KIM" CỦA NHỮNG PHÁT MINH VÃ KHÁM PHÁ VỀ ĐIỆN:

NĂM 1820 (Sau THIÊN-CHÚA):

Hans Christian Oersted (Đan-Mạch)dã khám phá ra rằng

một dòng diện làm lệch một kim nam châm treo.
Andre Ampere (Pháp) dã chứng minh sức phản ứng diện từ.

NĂM 1821 (Sau THIÊN-CHÚA):
Micheal Faraday (Anh quốc),nguyên lý dòng diện chạy trong chất dẫn diện xoay xung quanh một từ trường. Điều này dã làm căn bản cho động cơ diện.

NĂM 1825 (Sau THIÊN-CHÚA):
William Sturgeon (Anh quốc) chế ra nam châm diện dầu tiên.

-George Simon Ohm dã khám phá ra rằng diện thế (voltage), dòng diện (current), và diện trở (resistance) có một quan hệ nội tại có thể doán dược . Định luật Ohm dược viết là - E=I.R.

NĂM 1831 (Sau THIÊN-CHÚA):
-Joseph Henry (u.s.a) và Micheal Faraday (Anh quốc) dã khám phá riêng rẽ hiện tượng cảm ứng từ diện (electromagnetic induction) và phát sinh ra diện bởi từ lực.

-Faraday chế ra máy phát diện, máy phát cơ động diện (electro-mechanical generator) dầu tiên.

-Henry khám phá ra tác dụng của tự cảm ứng (self-induction) hoặc phần cảm diện (inductor).

NĂM 1837 (Sau THIÊN-CHÚA);
Samuel Morse (MỸ), phát minh ra máy diện tín dầu tiên.

NĂM 1839 (Sau THIÊN-CHÚA):
Karl Gauss (ĐỨC) công bố lý thuyết từ tính và những hấp lực (forces of attraction).

NĂM 1841 (Sau THIÊN-CHÚA):
Đèn hồ quang dầu tiên dược chưng giải ở Balê.

NĂM 1847 (Sau THIÊN-CHÚA):
George Boole thiết lập nền móng cho máy diện toán (computer) tân thời trong "luận lý toán học" (mathematical logic) của ông ta. Ngày nay dược biết như là dại số Boolean (Boolean Algebra).

NĂM 1858 (Sau THIÊN-CHÚA):
Faraday trông coi việc lập những máy phát diện dùng dể thắp sang những dèn hồ quang của các hải dăng ở Anh

NĂM 1866 (Sau THIÊN-CHÚA):

Cyrus Field lần đầu tiên thành công trong việc đặt đường dây điện báo xuyên đại tây dương.

NĂM 1873 (Sau THIÊN-CHÚA):

James Maxwell (Anh quốc), công bố trên báo khoa học của ông ta về lý thuyết bức xạ điện tử (theory of electromagnetic radiation). Điều này làm căn bản toán học cho những sóng âm thanh.

NĂM 1876 (Sau THIÊN-CHÚA):

Alexander Graham Bell (MỸ), phát triển tiện ích điện thoại đầu tiên.

NĂM 1879 (Sau THIÊN-CHÚA):

Thomas A. Edition (MỸ), đèn có tim bằng than (carbon-filament lamp). Đèn đầu tiên có tim cháy sáng (incandescent lamp).

-Ernest W. Von Siemens (ĐỨC) thành công với ba xe hoả điện.

NĂM 1880 (Sau THIÊN-CHÚA):

Edition lắp đèn đường thắp sáng thành phố NEW YORK.

NĂM 1883 (Sau THIÊN-CHÚA):

Edition đã khám phá ra hiệu ứng Edition, đã làm căn bản cho những khám phá về đèn điện tử.

NĂM 1866 (Sau THIÊN-CHÚA):

-Heinrich Hertz (ĐỨC) kiểm chứng những tiền đề toán học của Maxwell bằng cách sản xuất những sóng điện tử, và mở đầu cho lãnh vực radio thực tiễn.

- Edition được cấp bằng sáng chế ống vi âm (microphone).

-Dòng điện xoay chiều (alternating current) đầu tiên ở MỸ để thắp sáng những hệ thống thương mại.

NĂM 1888 (Sau THIÊN-CHÚA):

Nikola Tesla (MỸ) phát minh ra động cơ cảm ứng xoay chiều (AC induction motor). Công ty Westinghouse đứng ra sản xuất loại động cơ này.

NĂM 1892 (Sau THIÊN-CHÚA):

Công ty General Electric được thành lập.

NĂM 1896 (Sau THIÊN-CHÚA):

Ở Ý, Guglielmo Marconi gởi một điện tín âm thanh trên một khoảng cách 9 dặm.

NĂM 1897 (Sau THIÊN-CHÚA):

-Marconi chứng minh "vô tuyến từ tàu tới bờ biển".

-Karl Ferdinand chế ra dao động ký dùng tia âm cực (cathode ray oscilloscope).

NĂM 1899 (Sau THIÊN-CHÚA):

Âm thanh đầu tiên được ghi trên dây từ (magnetic wire).

NĂM 1900:

-William Duddel khám phá ra rằng điện hồ quang (electric arc) có thể được sản xuất những giao động liên tục. Điều này làm căn bản cho những máy phát khe hồ quang (Spark-gap transmitters).

-Giáo sư Reginald Fessenden chuyển bản văn bằng vô tuyến.

NĂM 1901 :

Bản văn đầu tiên chuyển xuyên đại tây dương bằng vô tuyến.

NĂM 1903:

Tiến sĩ Ernest Alexanders chế ra đầu tiên tần số cao xoay chiều (high-frequency alternator) ở General Electric sản xuất một sóng 100Khz.

NĂM 1904 :

Giáo sư John Fleming được cấp bằng sáng chế một dụng cụ có hai phần tử gọi là nhiệt xạ (thermionic) cũng còn được gọi là đèn điện tử Fleming dựa trên hiệu ứng Editon, được dùng để khám phá sóng điện từ và ngày nay được gọi là đèn điện tử lưỡng cực.

KỶ NGUYÊN CỦA ĐÈN CHÂN KHÔNG (1905-1948):

NĂM 1906:

Tướng Dunwoody đưa ra một loại tinh thể tách sóng (crystal detector), ông đã dùng chất Carborundum để tách những tín hiệu.

-Tiến sĩ Lee de Forest (MỸ) thêm một cực lưới khiển vào đèn điện tử Fleming, kết quả ta có đèn điện tử Audion, chính đèn này đã làm nền móng cho nền điện tử hiện đại.
Đèn Audion ngày nay được gọi là đèn ba cực (triode tube).

NĂM 1915:

Lần sóng diện âm thanh dầu tiên xuyên dại tây dướng dược phát di từ MỸ quốc.

NĂM 1917:

George Camble dưa ra mạch lọc sóng diện dầu tiên. Điều này làm cho các băng tần có thể thông tin dược với nhau.

NĂM 1920:

-KDKA Pittburgh - Đài phát thanh dầu tiên bắt dầu hoạt dộng.

-Edwin Armstrong, chế ra mạch Siêu tha phách (super heterodyne)-Bậc thầy của các máy thu thanh hiện dại

NĂM 1923:

Tiến sĩ Vladimir Zworykin dược cấp bằng sáng chế dể chế tạo dèn thu hình của máy vô tuyến truyền hình.

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TRANG 6

NĂM 1925:

Truyền hình được trình bày bởi John Baird ở Anh quốc.

NĂM 1929:

Tiến sĩ Vladimir Zworykin trình bày đèn hoạt ảnh (kinescope), đèn hình tối tân đầu tiên.

NĂM 1930:

W. Blair có bằng sáng chế hệ thống ra-da căn bản đầu tiên

NĂM 1931:

Dao động kế (oscilloscope) được sản xuất bởi Allen Dumont.

NĂM 1933:

Karl Jansky khám phá ra khoa thiên văn vô tuyến (radio astronomy).

NĂM 1937:

Anh em Varian phát minh ra đèn điện tử Klystron - một loại sóng vi ba có công suất cao (a high power microwave oscillator).

NĂM 1938:

William Hewlett và David Packard cộng tác để sản xuất máy Diathermy cho bệnh viện Stanford.

NĂM 1939:

Đài truyền hình NBC dùng loại đèn thu ảnh Orthicon được cải tiến bởi RCA.

NAM 1941:

Đài phát thanh FM thương mại bắt đầu tại MỸ vào ngày 1 tháng giêng.

-Đài truyền hình thương mại được phép hoạt động vào ngày 1 tháng bảy.

-Hệ thống ra-da quân sự cải tiến ở Pearl Harbor ngày 7 tháng 12.

NĂM 1942:

Băng từ ghi âm được cải tiến.

NAM 1944: -

- Một trong những máy tính điện tử digital được cải tiến bởi Howard Aiken ở trường đại học Harvard được gọi là máy tính automatic-sequence- controlled và được dùng rộng rãi trong ngành hải quân MỸ.
- V-beam được giới thiệu bởi phòng thí nghiệm bức xạ MIT. -lần đầu tiên được dùng như đa dụng rada.

NĂM 1946:

-Lần dầu tiên RCA giới thiệu máy truyền hình ĐEN được sản xuất theo lối dây chuyền; kiểu 630TS-đen hình 10 inch, giá bán $375.

-Máy tính diện tử Eniac được cải tiến bởi Lokert và Mauchly thuộc dại học Pennsylvania. Máy diện toán có ~~thể~~ dùng chương trình (Digital programmable machine), có thể làm 5,000 phép toán mỗi giây, nặng 30 tấn, chứa 18,000 dèn diện tử, và cần 130kw. Ngày nay máy này chỉ bằng một máy tính diện tử cầm tay.

-Lần dầu tiên RCA đưa ra máy T.V màu "all electronic".

NĂM 1947:

Tháng 12 tại phòng thí nghiệm BELL : lần dầu tiên tín hiệu được khuếch dại bởi một tinh thể chất bán dẫn được quan sát. John Bardeen, Walter Brattain, và William Shockley thực hiện có kết quả trong Germanium tiếp diểm transistor (Germanium point contact).

KỸ NGUYÊN CỦA TRANSISTOR (1948 - 1959):

NĂM 1948:

Transistor được sinh ra - mở dầu cho ngành diện tử hiện dại.

NĂM 1949:

Kỷ lục thương mại bị phá vỡ, loại 78 Rpm bị loại . RCA dưa vào loại 45 Rpm disc, trong khi CBS cải tiến loại hình thức 33-1/3.

NĂM 1951:

Máy tính diện tử Univac I được giới thiệu bởi Remingtonrand Corporation).

NĂM 1952:

Lần dầu tiên RCA làm những thí nghiệm tất cả dùng transistor cho máy truyền hình.

-Andrew Kay dầu tiên thực hiện máy do diện thế digital. tại công ty Non Linear Systems.

NĂM 1953:

H.J Zeigler cải tiến tia maser - một dụng cụ mà có thể khuếch dại sóng diện tử với ánh sáng. Máy khuếch

dải này là tiền thân của tia laser.
-RCA tiết lộ một máy phát sóng FM rất nhỏ có thể nuốt được. Ngày nay các phi hành gia dùng những viên phát sóng này để gởi những dữ kiện vật lý về địa cầu.

NĂM 1958:

-Đầu tiên mạch khối (integrated circuit) được đưa ra bởi Jack Kilby ở Texas Instruments. Mạch đơn sơ chỉ chứa vài transistor, một vài điện trở, và một vài tụ điện.. Ngày nay , mạch tương tự có thể chứa hàng chục ngàn transistor. Ở cùng thời điểm ấy tại Fairchild's Semiconductor Division, Tiến sĩ Robert Noyce đã cải thiện một loại mạch tương tự mà trong đó là những mạch khối hoặc được thu lại trên một "chip"đơn độc của silicon.
-GE và Crystalonics đưa vào thương mại loại FET (field effect transistors).
_Những máy hát âm thanh nổi bắt đầu xuất hiện.
Một số đài phát thanh bắt đầu cho phát thanh âm thanh nổi.

NĂM 1959:

RCA đưa ra loại đèn vi tử nuvistor, mot loại đèn điện tử có kích thước của vòng bao tay khâu ,được coi như toan tính cuối cùng của các nhà sản xuất để kình chống lại những dụng cụ xài transistor.

KỶ NGUYÊN CỦA MẠCH KHỐI (INTEGRATED CIRCUIT) -(1959-):

NĂM 1960:

Fairchild phát triển tiến trình cho việc sản xuất những transistor và mạch khối. Tiến trình này bao gồm việc làm bốc hơi nhôm trên mạch điện để làm thành những dây dẫn điện.
-Texas Instruments tặng cho loạt sản xuất mạch khối đầu tiên được gọi là "solid circuit series 1", mạch logic đơn giản.
-Phòng thí nghiệm Bell phát triển tiến trình "epitaxial". phương pháp này cho phép một cấu trúc tinh thể được lớn lên trên một "substraight" hoặc một tinh thể cấu trúc khác. Kỹ thuật này đã trở nên chính yếu trong việc chế transistor và mạch khối.

NĂM 1961:

Những máy laser dược cải tiến bởi Hughes, Bell labs, Raytheon, và IBM.

NĂM 1962:

Điện trị laser dược cải tiến do những phòng thí nghiệm sưu tầm của GE và IBM.

-Signetics giới thiệu "diod- transistor logic".

-Tektronix giới thiệu khái niệm của "plug-in modules" cho khí cụ trắc nghiệm.

NĂM 1954:

-Phòng thí nghiệm Bell hoàn hảo một phương pháp trồng đơn tinh thể silicon. Sự cải tiến này đã làm nền móng cho hãng tỷ MỸ kim kỹ nghệ chất bán dẫn (semiconductor industry).

-Calvin Fuller của phòng thí nghiệm Bell phát triển tiến trình khuếch tán (diffusing) những chất bẩn (impurities) vào trong mặt của những dĩa nhỏ silicon (silicon wafers), lót dường cho sự phát triển mạch khối (integrated circuit).

-Texas Instruments giới thiệu silicon transistor.

-Dary Chapin, Calvin Fuller, và Gerald Pearson ở phòng thí nghiệm Bell cải tiến pin dùng ánh sáng mặt trời (solar battery).

-Những transistor dầu tiên dược dùng cho những sản phẩm tiêu thụ. Regency Company bán ra loại máy thâu thanh bốn tansistor.

NĂM 1955:

Tappan giới thiệu bếp lò vi-ba (microwave oven) để dùng trong nhà.

-Mucan Corporation và phòng thí nghiệm Bell cải tiến loại "varacator diode" rồi thì dượcbiết như là tụ điện biến đổi điện thế (voltage variable capacitor) và dược dùng hiện nay cho máy thu thanh và thu hình.

NĂM 1956:

-Bell và Howell giới thiệu máy quay phim điện tử.

-Phòng thí nghiệm Bell chứng tỏ rằng có thể thực hiện dược điện thoại truyền hình (TV telephone).

-GE thương mại hoá loại mạch chỉnh lưu silicon SCR

NĂM 1957:

-Liên-Xô phóng vệ tinh Sputnik - Vệ tinh nhân tạo đầu tiên dược phóng lên quỹ đạo.

-Burroughs Corporation lần đầu tiên dưa ra loại dèn nixie- loại dèn chạy hiện số (numerical readout tube)

-U.Gianola thuộc phòng thí nghiệm Bell dưa ra loại dây dẹt ký ức (wire memory). Tại công ty IBM,người ta dùng những dĩa ký ức to lần đầu tiên có thể chứa tới 5 triệu chữ (character).

-Dèn lưỡng cực (LEDs) lần đầu tiên dược dưa ra , mặc dầu chưa dem ra thị trường , cho dến năm 1968 mới có bán ra thị trường.

-Telestar, vệ tinh thông tin phóng di ngày 10 tháng 7, có thể chuyển các chương trình truyền thanh truyền hình.

NĂM 1963:

- Lần đầu tiên máy tính diện tử cỡ nhỏ do công ty Digital Equipment Corporation, kiểu PDP-5 loại 12 bit và có 1k ký ức. Dược bán ra giá $27,000.

-Sylvania lần đầu tiên dưa ra loại mạch khối (integrated circuit) dùng TTL logic.

NĂM 1964:

-IBM dưa ra hàng loạt máy tính diện tử hệ thống 360 dược dự trù thay thế tất cả máy IBM dang xài.

-Zenith sản xuất một trong những sản phẩm tiêu thụ dùng mạch khối, dó là dụng cụ nghe cho người diếc.

-Texas Instruments dưa ra hàng loạt loại 5400 TTL logic

-Fairchild dưa ra một trong những mạch khối tuyến tính đầu tiên- Loại máy khuếch dại 702 OP.

-Loại DIP (dual inline package) xuất hiện lần đầu tiên.

NĂM1966:

Andrew Bobeck tuyên bố cải tiến loại magnet-bubble.

NĂM 1966:

RCA giới thiệu một loại mạch khối mới dó là COS/MOS.

NAM 1969:

Ngày 20 tháng 7, hai phi hành gia Armstrong và Aldrin của phi thuyền Apollo 11 , dã dáp xuống mặt trăng. Đã thành công rực rỡ và trở về dịa cầu dánh dấu kỷ lục thập niên của ngành diện tử.

NĂM 1970:

-

-Intel lần dầu tiên dưa ra loại ký ức dynamic MOS loại 1025-bit. Trước dó, ký ức của các máy tính diện tử dùng loại nhân từ (magnetic cores) hoặc những chất bán dẫn (semiconductors).

-Mostek và TI dã chứng tỏ rằng tất cả logic cho một máy tính với bốn nhiệm vụ (a four function calculator). có thể dược dặt trên một miếng nhỏ (chip),kỹ thuật này dược biết như là MOS/LSI.

-Harris Semi conductor giới thiệu một loại ký ức mới mà người dùng có thể viết chương trình (user programmable memory).

-Hamilton dưa ra dồng hồ deo tay hiệu "Pulsa", một loại dồng hồ deo tay dùng dèn lưỡng cực (LED) dể chớp giờ. Giá $2100.

NĂM 1971: -

-Ted Hoff dưa ra loại "trung tâm diều hành máy tính diện tử" (micro processor) dầu tiên dó là Intel's4004. Sau dó không lâu lại dưa ra loại 8008 CPU.

-Bước dầu của những loại máy tính cầm tay chỉ có 4 phần sự sản xuất bởi Hewlett Packard, Sharp, va Texas Instrument dược bán với giá $400.

NĂM 1972:

_Tinh thể lỏng dược dùng dể trình bày số dọc, tiêu thụ ít diện và những số hiện rõ rất dễ dọc.

-Microma Universal dưa ra dầu tiên loại dồng hồ deo tay dùng tinh the lỏng (liquid crystal) , giá $150.

-Magnavox dưa ra thị trường dầu tiên "môn chơi truyền hình" (TV game). Atari theo sau với hiệu Pong năm 1976.

NĂM 1973:

-Intel chỉnh dốn 8008 và dưa ra loại 8080. National Semiconductor và Rockwell dều có chế tạo riêng microprocessor.

-I^2L (integrated injection logic) là sản phẩm chung của hai công ty IBM và Philips. Đây là một loại mạch diện kỹ thuật mới có mật dộ cao, tốc dộ nhanh, nhưng tiêu thụ ít diện và ít hao hớt. Đây là loại 4-bit microprocessor và một mạch đồng hồ - được đưa ra bởi Texas Instruments.

-Advent đưa ra "Video Beam".

NĂM 1975:

-Hệ thống thu băng Video dùng trong nhà được sản xuất bởi AVCO (Cartivision), Sony (Betamax), và những hãng khác.

-Máy tính điện tử loại dùng trong nhà xuất hiện trên thị trường trong lãnh vực giải trí và cho ngành kỹ sư. Những máy này căn bản là dùng microprocessor đầu tiên được bán trong những túi nhỏ do các công ty như MITS (altair), Sphere, IMSAI, và Southwest Technical Products. Những máy này căn bản là dùng 8080 hoặc 6800. Giá cả của những máy này bị ảnh hưởng của việc sản xuất LSI chip ,làm cho giá của microprocessor chip sụt từ $200 xuống chỉ còn $20 mỗi cái .

-Những máy dò khói ion hoá và - được dùng trong nhà.

NĂM 1976:

-Máy đo cơ thể, một loại máy quang tuyến X có thể phân tích toàn thân thể con người dùng cho việc phát triển y học,, bướu, vấn đề về xương... được giới thiệu bởi GE.

-Hệ thống đánh lửa điện tử trở thành trang cụ chánh hoặc được thêm vào cho xe hơi.

NĂM 1977:

-40-băng tần CB thu thanh được chấp thuận bởi FCC.

-Thế hệ đang lên của những máy tính điện tử dùng trong nhà (home computer). Những hệ thống này được ráp trước, với chương trình đơn giản (simplified programming), và giá lại hạ. Điển hình như là Radio Shack TRS-80, Commodore PET, và AppleII.

-Hệ thống thông tin đầu tiên trên thế giới dùng fiber-optic để cung cấp hoạt động của điện thoại đã được đưa vào hoạt động bởi General Telephone Company. Đã tốn rất nhiều năm và thí nghiệm với fiber optic và những nguồn ánh sáng thích hợp.

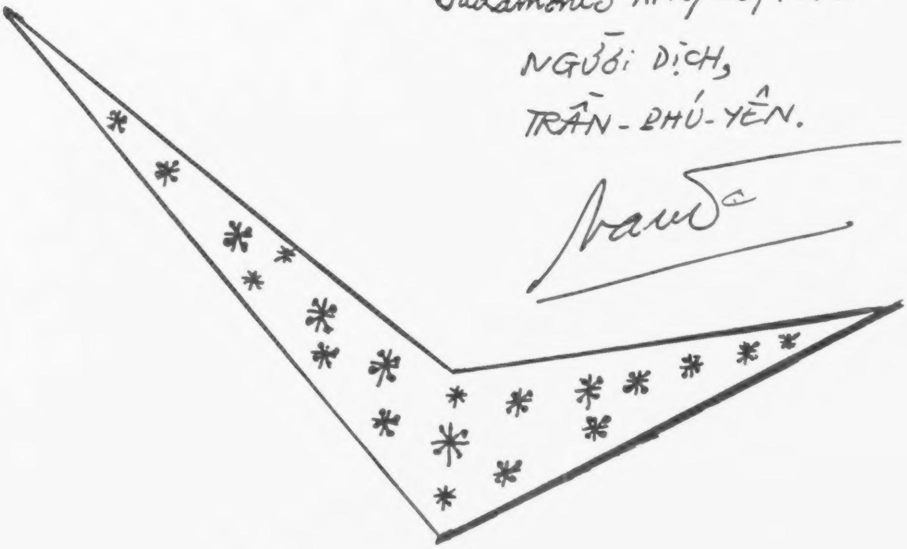
Năm 1978:

Một kỷ nguyên mới của micro-processor chip dựa trên căn bản 16-bit chữ (16-bit words) thay vì loại thông dụng 8-bit chữ (8-bit word) hứa hẹn sẽ đưa đến sự hoàn thành 10 lần nhanh hơn loại chip tiêu chuẩn kỹ nghệ đó là chip 8080./.

Sacramento APR/20/1986.

NGƯỜI DỊCH,

TRẦN-PHÚ-YÊN.



ELECTRONIC CURRICULUM

VOCATIONAL TRAINING LESSON PLAN **# III** Tool Use

Teaching Materials Source ______________________
Chapter ____________, pages ____________
Lab Manual pages ____________
Additional Instructor Materials ______________________

Main concepts student will learn:

To promote basic electrical skills and interest in electricity by conveying those competencies relevant to successful tool usage, wiring, and project assembly techniques.

The student will be able to:

1. describe the function, list safety precautions, and illustrate the correct use of each construction tool presented in this unit.
2. identify and demonstrate proper soldering techniques and method of preparing conductors for electrical utilization.
3. successfully construct a Wiring Project, and demonstrate their competence in following instructions, tool use, chassis layout, soldering, assembly techniques, inspection, and testing.

Length of Lesson

2 - 4 weeks

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which utilizes a combination of written, oral, and laboratory testing procedures.

Technical Vocabulary

Tool and related equipment names.
see glossary

Related General Vocabulary

Teaching Activity

1. Demo and description of each hand tool.
2. Demo the process used to fabricate pc boards.
3. Students should build several projects as selected.

Materials and Notes

Robert Delp is a good source of project schematics, PC Board patterns, & sheet metal layout.

Robert Delp Electronics
Box 1026
Fremont, CA 95838

Instructor References:

Electronics Assembly and Fabrication Methods. S. R. Duarte and R. L. Duarte, McGraw-Hill Book Co., 1973. Chapters: 1,5,6,7,8,9, and 10.

Electronic Techniques. R. S. Villanucci, A. W. Avtgis, and W. F. Megow, Prentice-Hall, Inc., 1974. Chapters 3-16.

Technical Electricity and Electronics. Peter Buban and Marshall L. Schmitt, McGraw-Hill Book Co., 1977. Units: 27-31.

SCORE:

GRADE:

Name:

Date:

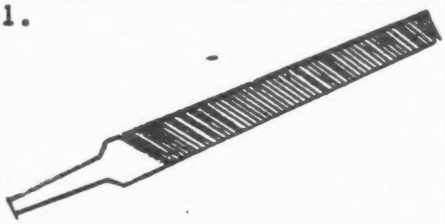
Period:

WORKSHEET

VOCABULARY - TOOL AND HARDWARE IDENTIFICATION

Identify the items pictured below. Use complete names.

1.



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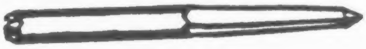

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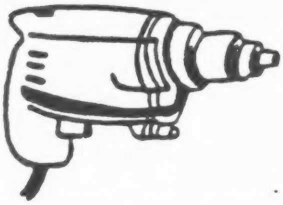

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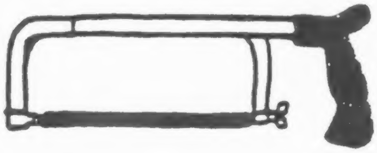

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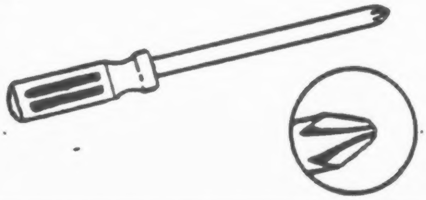

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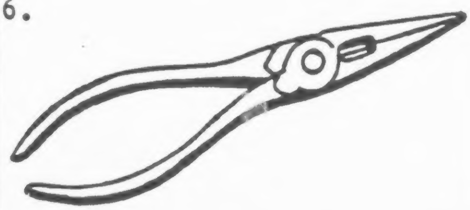

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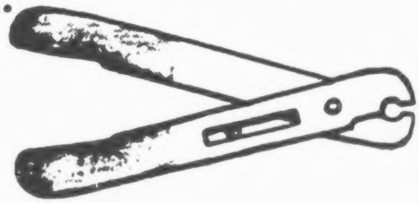

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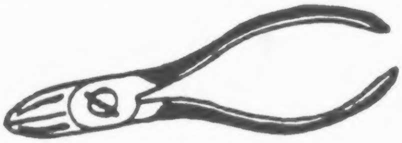

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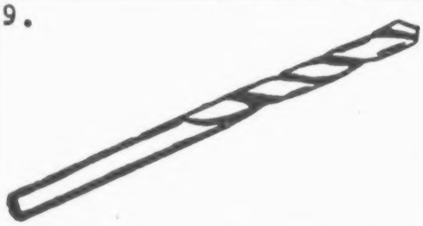

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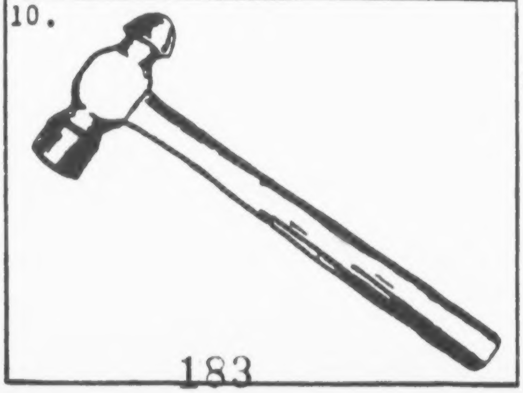
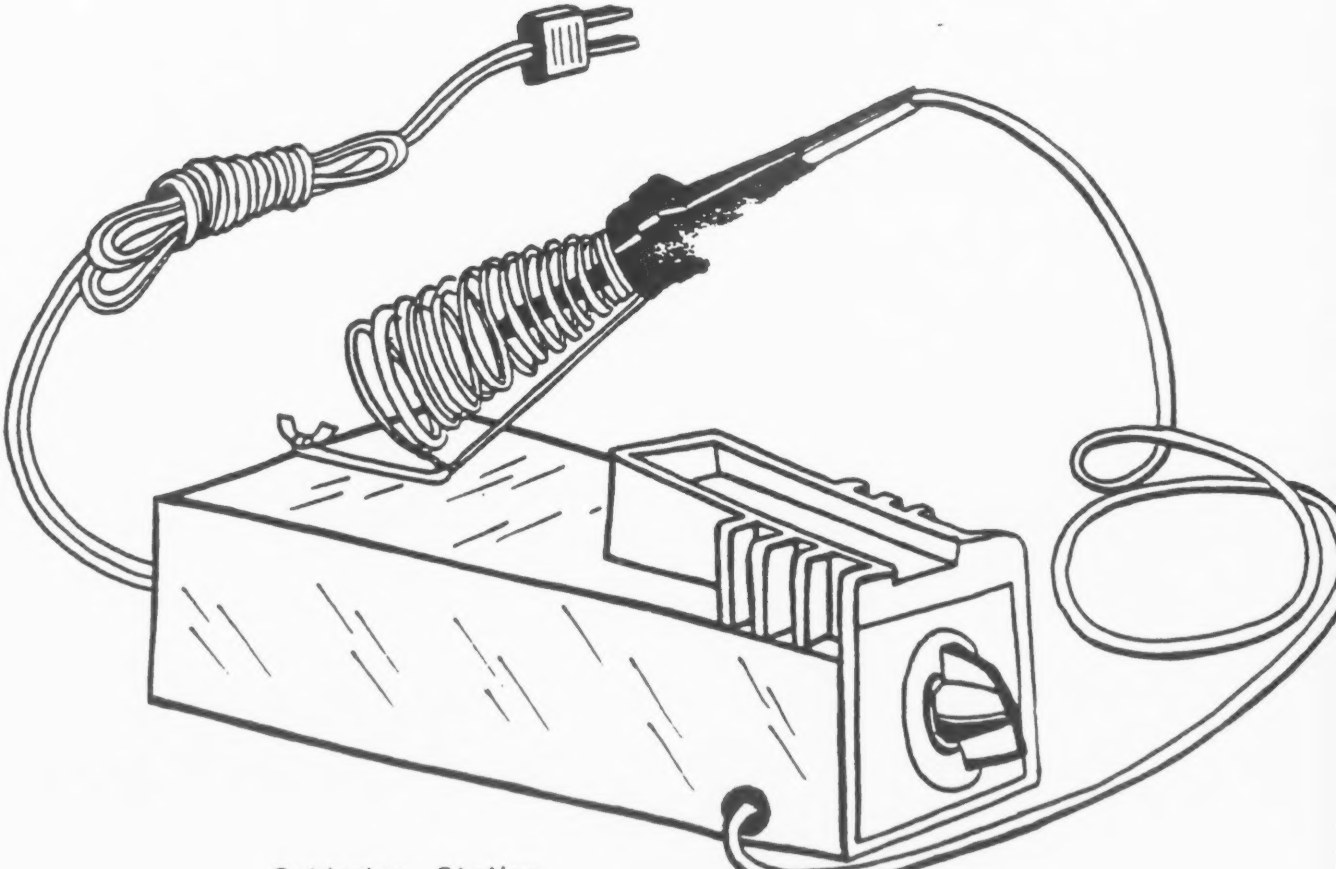


9.

10.

TWIST DRILL:	A style of drill bit made of carbon steel, and used for drilling holes in metals. The twist drill is used in conjunction with a drill press or portable electrical drill.
VISE:	A tool used to securely hold work pieces while drilling, cutting, soldering, etc.. The most common style of vise, is called a bench vise, although many specialty vises are available for electronics work.
WIRE STRIPPERS:	A common tool used to remove the insulation from a conductor or wire.



Soldering Station

SOLDER:	An alloy of tin and lead which is melted into an electrical connection to increase conductivity, improve mechanical strength and to protect against oxidation. Solder used for electrical work is generally designated as 60/40 rosin core. That is: 60% tin and 40% lead with a central core of rosin. This type of solder has a melting point of 370° F, good mechanical strength, and solidifies rapidly.
SOLDER JOINT:	The process of cleaning, heating, and properly applying solder to a connection, splice, or joint.
SOLDERING IRON:	A tool, with a heated tip, used to transfer heat to a connection for soldering. The style of iron used for general electronic work is called a "pencil" iron and has a rating between 25 and 40 watts.
SOLDERLESS CONNECTOR:	Also designated as solderless terminals or crimp connectors, these devices do not require soldering, rather, the wire is inserted into a lug, and the lug is squeezed, with a special tool, to make the electrical connection.
SOLID WIRE:	A style of wire that consists of only one solid conductor, usually surrounded by insulation.
SPLICE:	A method for connecting two or more wires together. Ex. Tap splice, rat-tail splice, or Western Union splice.
SQUARING SHEAR:	A piece of stationary equipment used for cutting, trimming, and squaring sheetmetal. The cutting blade is operated either by a foot treadle or lever handle.
STRANDED WIRE:	A type of wire which consists of many strands of fine wire twisted together. The twisted conductors are then covered with an insulating material. Stranded wire is more flexible than solid style wire of the same gauge.
TAPPERED HAND REAMER:	A "T" shaped tool used to slightly enlarge the size of a hole drilled in metal or sheetmetal.
TINNING:	The process of cleaning and coating with solder. Tinning is usually thought of in connection with preparing the heated tip of a soldering iron, but wires, terminals, printed circuit boards, and component leads are often tinned in preparation for making an electrical connection
TIN SNIPS:	A scissors like tool used for cutting sheetmetal.
TRACE:	Copper foil patterns which are left on a printed circuit board. These foil traces act as the interconnecting wires between the components.
TWIST-ON CONNECTOR:	A type of insulated solderless connector used for making rat-tail joints. To use a twist-on connector, thread it onto a pair of bare conductors which are held parallel to each other. The conductor will twist and hold the conductors firmly together.

Name: ____________

Date: ____________

Period: ____________

TECHNICAL GLOSSARY

ADJUSTABLE WRENCH:	An open-end style wrench with adjustable jaw size. This type of wrench is designed with one stationary jaw, and an adjustable jaw operated by a thumb screw. This feature allows one wrench to be used on many different nut or bolt sizes.
ASSEMBLY:	The fitting together of parts, utilizing tools and necessary equipment, to form a complete unit or device.
AVIATION SNIPS:	Sheetmetal cutting shears which have a compound lever action which reduces cutting effort.
BALL-PEEN HAMMER:	A general purpose metal working hammer with one flat face for hammering and a rounded or "ball" head for rounding off rivets.
BOX AND PAN BRAKE:	A heavy duty sheetmetal tool with adjustable fingers used to make inside and outside bends from about 180° to 40°.
CABLE TIES:	Small nylon belts or straps, with a self-locking buckle, used to bind or harness wires together.
CENTER PUNCH:	A metal punch with a sharp 60° point. The center punch is used to mark the location of a hole that is to be drilled and thus eliminate drill "wandering."
CHASSIS:	A metal box or frame upon which major components or sub-circuits are mounted and wired.
CHASSIS PUNCH:	A sheetmetal punch designed for punching round holes in a range of sizes from 1/2" to 3". The punch halves are drawn together with a machine screw. Chassis punches are also available in square, keyed, and half round styles.
COMPONENT:	A general term describing an electrical part or parts. For example; basic electrical parts such as resistors, capacitors, diodes, and transistors, can be identified as components.
CONDUCTOR JOINTS:	A method for connecting or securing two or more wires together. A satisfactory conductor joint must be 1) mechanically secure - wires tightly twisted together, 2) electrically secure - the connection must freely pass current, and 3) covered with an approved insulation.
DESOLDERING TOOL:	A device used to remove molten solder from a wire or connection. Most desoldering tools draw the molten solder from the connection with a vacuum or suction force.

DIAGONAL-CUTTING PLIERS:	Pliers used for cutting soft metal wire. Two popular terms used for identifying these pliers are diagonals and dykes.
DRILL PRESS:	A motorized tool used for drilling or boring holes in a piece of stock. Drill bits are held securely in the chuck, and fed into the work with the feed handle.
ELECTRICAL CONNECTION:	Provides a connection that will conduct electricity as efficiently as a continuous wire. A good electrical connection requires that the wires be absolutely clean and that they be twisted together to achieve good contact, many times solder is added to the joint to achieve good electrical contact.
ELECTRICAL TAPE:	A black vinyl insulating tape used to cover exposed conductor joints.
ETCHING:	The process of chemically removing the excess copper from a circuit board. The more common etching solutions are ammonium persulfate or ferric chloride.
FILE:	A tool used mainly to smooth the edges of sheetmetal, and to do small amounts of cutting, shaping and fitting of metal parts.
FLUX:	A chemical used to remove oxygen during the soldering process and to clean the copper surface of slight oxidation. Flux aids in making a good solder joint. For electrical work use only rosin flux, which is available as a paste, or as a core in the solder itself.
GAUGE:	A standard method for sizing wires. Gauge sizes are given as numbers, such as 24 gauge or 24g. The lower the number, the larger the diameter of the wire.
HACKSAW:	A hand saw used for cutting metal. The hacksaw cuts on the forward motion only.
HAND PUNCH:	A sheetmetal hole punch used for punching small round holes up to approximately 1/2" in diameter. The tool uses a collection of punch and die sets which are mounte (one size at a time) in a handle/frame unit.
HARDWARE:	Items designed to provide physical or electrical support for projects. Physical support hardware includes items like screws, bolts, clamps, nuts, and spacers, while electrical support items include switches, lamps, socket fuses and terminals.
HARNESS:	Individual wires tied together into a neat bundle and routed through the project as a group. A harness typically has wires leaving the bundle at various locations.
HEAT SINK:	A small metallic tool used to draw heat away from a component or connection during the soldering process.

HEAT SHRINKABLE TUBING:	An insulating tubing which is slipped over a connection or joint. When the tubing is heated, with a heat gun, match, or soldering iron, it will shrink and form tightly around the connection.
INSULATION:	A material placed around a conductor, connection, or joint to prevent a short circuit or an accidental shock.
LACING:	The process of making a series of special ties with a piece of lacing cord along the length of a cable.
LONG-NOSE PLIERS:	Pliers used primarily for handling small objects and for bending and shaping wires. Most long nose pliers also incorporate a cutting jaw for cutting small gauge wires.
MAGNET WIRE:	Wire used in making coils in inductors, small transformers, relays, etc. The wire is usually insulated with a clear coat of enamel or varnish.
MECHANICAL CONNECTION:	The process of attaching wires to terminals, or another wire, by twisting or bending them in such a way that the connection remains secure even though it is not soldered.
NUT DRIVER:	A tool designed to rapidly install or remove nuts. The tool resembles a socket wrench attached to a screwdriver handle.
OPEN-END WRENCH:	A general purpose wrench which has an open jaw, of different size, at either end of the tool.
PORTABLE ELECTRIC DRILL:	A hand-held power tool used for boring holes in various materials. The tool utilizes a chuck to hold the drill bit and generally has a trigger style switch as a control.
PRINTED CIRCUIT BOARD:	Consists of metal foil conductors, usually copper, bonded to a substrate or base material. The base material supports the components which are loaded into holes drilled in the board, and soldered to the conducting foil. Foil traces serve as the interconnecting wires for the circuit.
RESIST:	A material used in printed circuit board fabrication to cover or coat the areas which are to be saved on the copper-clad board. The resist will form a pattern similar to the pattern of the completed printed circuit board traces.
SCREWDRIVER:	A tool which allows you to produce a twisting motion to tighten or loosen screws. The two common tip types are slotted or standard and Phillips-head.
SIDE CUTTER PLIERS:	Side cutter pliers or lineman pliers are heavy duty pliers used for gripping and cutting large gauge wires.
SLIP JOINT PLIERS:	A common type of plier designed for holding or gripping work. The slip joint permits the jaws to be opened wider.

Name: ____________________

Date: ____________________

Period: ____________________

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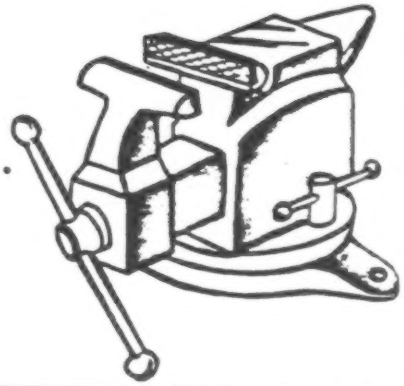

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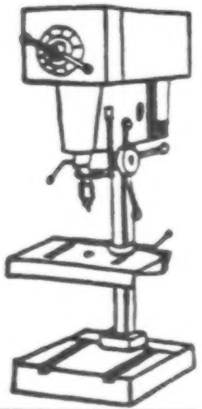

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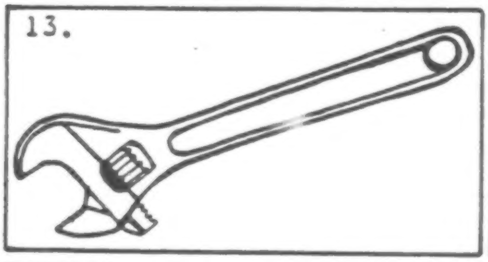

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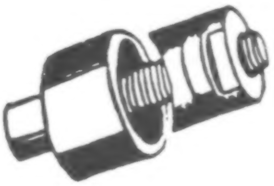

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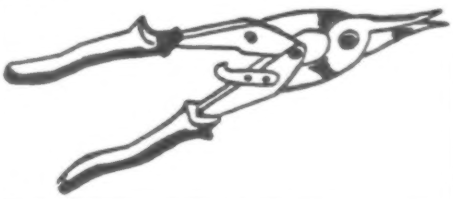

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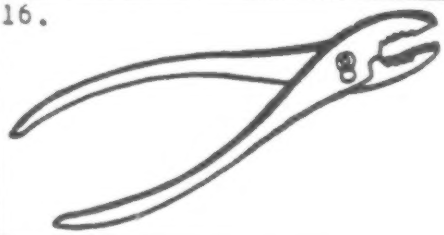

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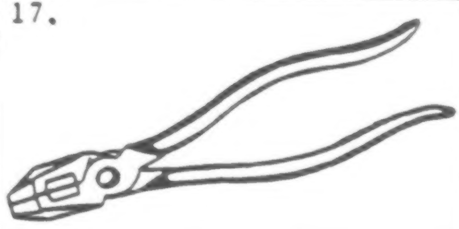

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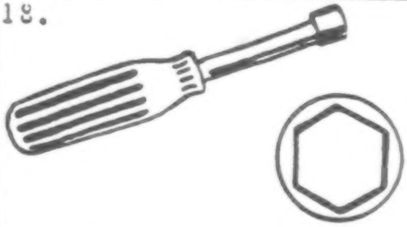

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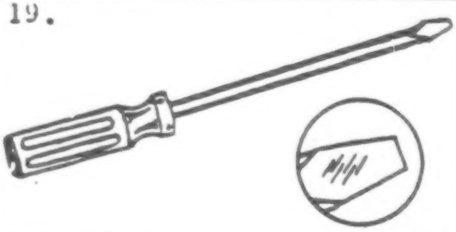

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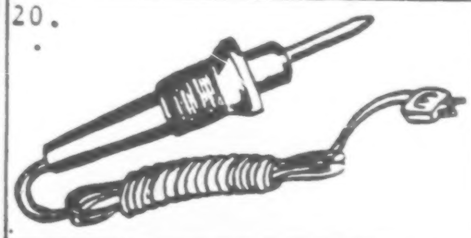

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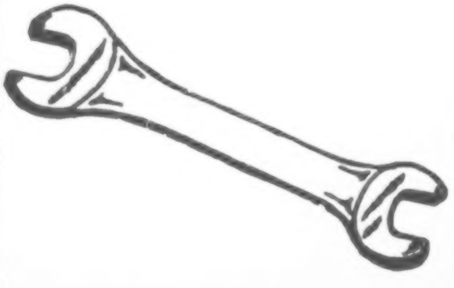

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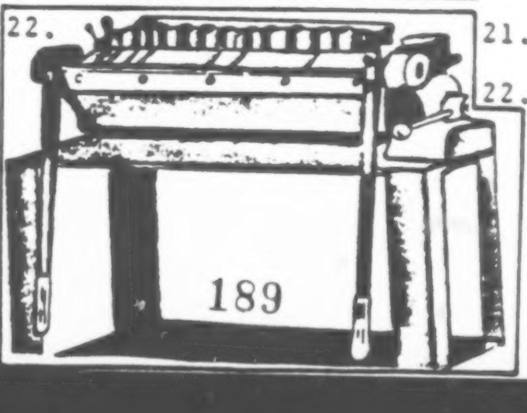

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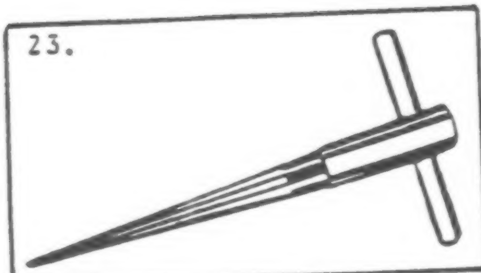

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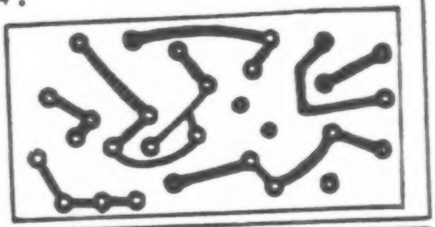

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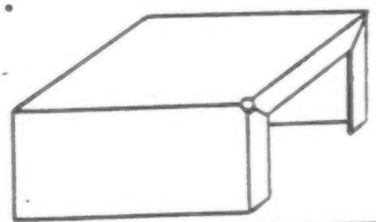

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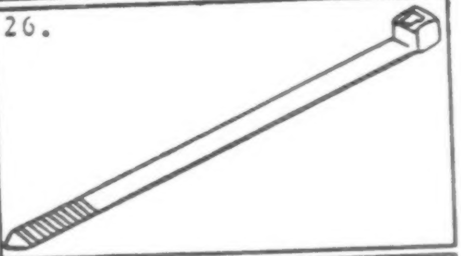

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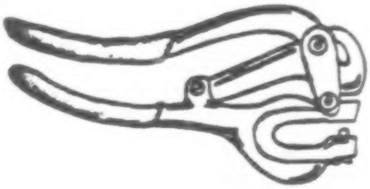

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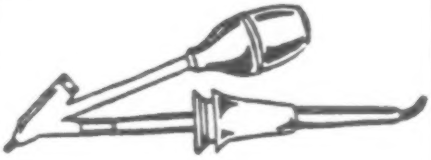

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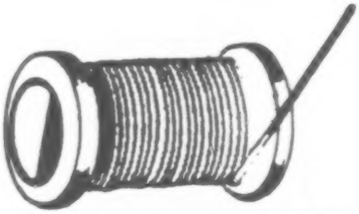

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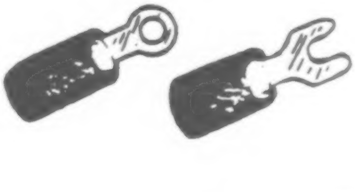

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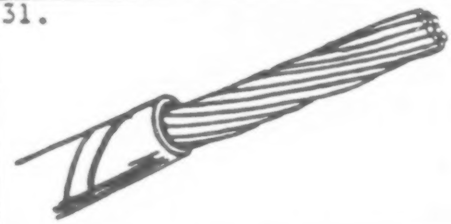

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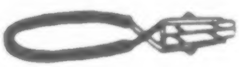

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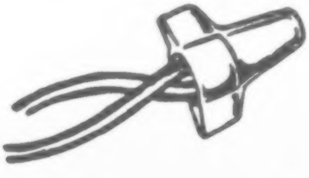

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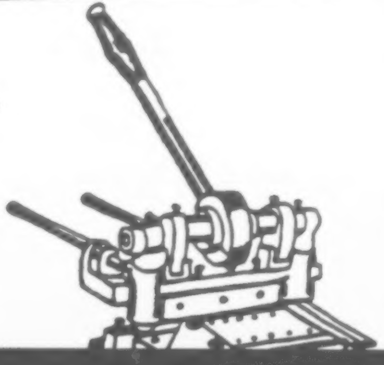

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SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

SOLDERING, SPLICES, AND PC FABRICATION

1. Identify the three important reasons for soldering an electrical connection:

1	2	3

2. Make a list of the steps that should be followed in making a good solder connection. Explain each step where necessary.

3. Draw a neat sketch of the following types of wire splices.

Rat-Tail Splice

Name: ____________

Date: ____ ____

Period: ____________

Tap Splice

Western Union Splice

4. Describe the method or technique used in the laboratory or resist material to a PC board. Be specific.

Apply Resist Material

____

____

____

____

____

5. Explain the procedure and precautions to be followed while a PC board.

Etch the Board

Procedure	Safety Precautions
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

Name: ____________________

Date: ____________________

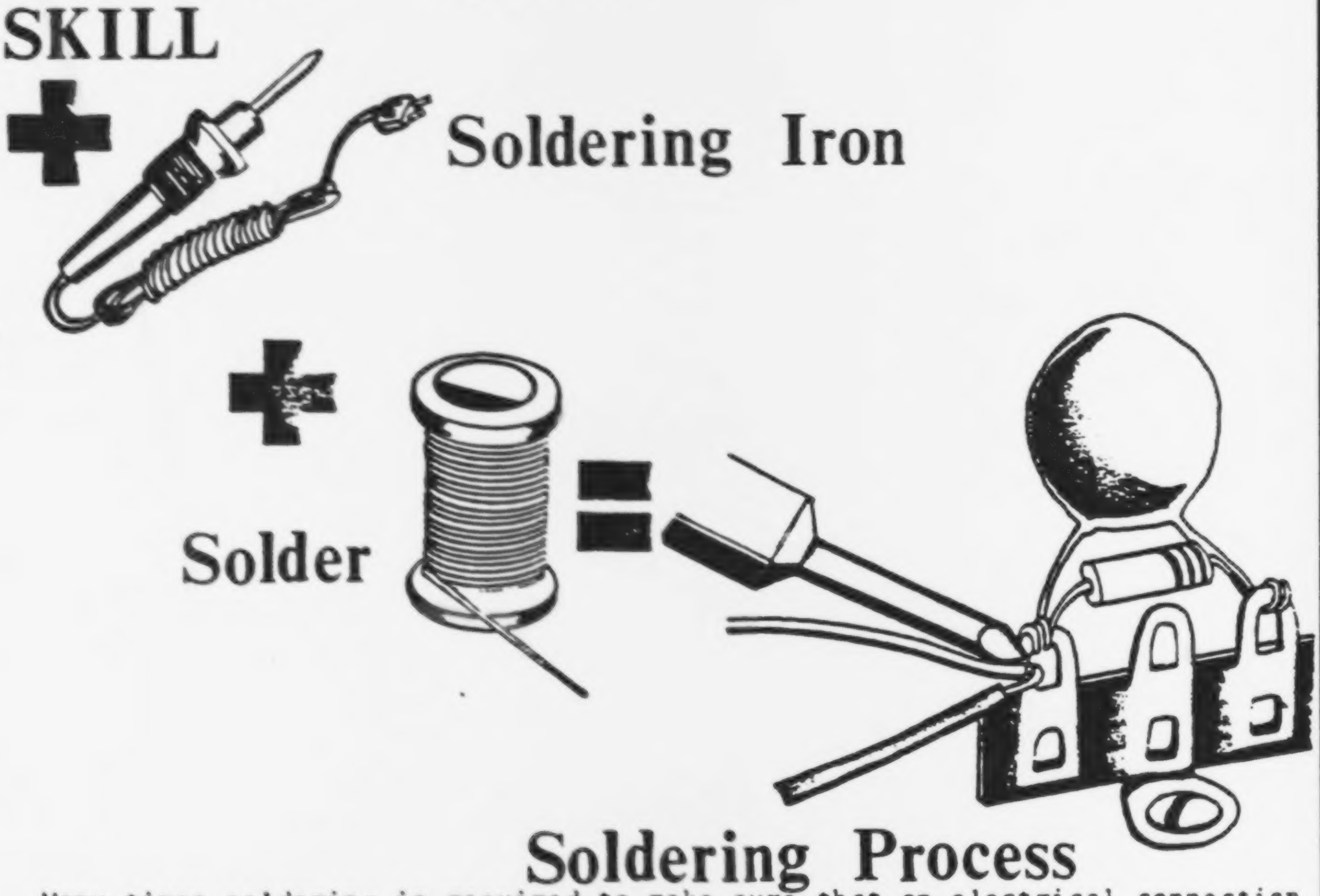
Period: ____________________

INFORMATIONAL HANDOUT

A 4 STEP GUIDE TO SOLDERING

INTRODUCTION: What is soldering?

In all Electricity/Electronics work, high quality soldering connections are important. Soldering is a process that allows the joining together, both mechanically and electrically, of metal objects (wires, component leads, etc.) through the use of a material called solder and a heating device described as a soldering iron.



Many times soldering is required to make sure that an electrical connection will last for a long time. Proper soldering will also ....

- Prevent corrosion
- Add strength

Name: ______________

Date: ______ ______

Period: ______________

① Selecting Soldering Tools and Materials:

Always use the correct tools and materials to accomplish the task; a
remember, proper use of tools and materials will increase your skill
and the quality of your work. Check the following list when prepari
solder.

☐ Safety glasses
☐ Proper wattage (heat) soldering iron and tip
☐ Rosin core solder - 60/40
☐ Solder aid
☐ Solder remover tool/braid
☐ Damp sponge
☐ Misc. hand tools
☐ Bench vice

② Soldering Procedures:

Proper soldering technique requires the learning of a skill, and th
best way to learn a skill is to practice. Study the list below of
procedures that you should follow each time it is necessary to old

Obtain tools and materials
Plug iron in and clean tip
Tin the tip
Prepare parts to be soldered
Make mechanical connection
Protect heat sensitive parts
Apply solder
Don't move parts
Visual check

③ Inspection:

Check your work immediately upon completion to avoid making a poor
soldering connection. Poor connections are generally caused "t
specific problems. However, you can fix each of these problems by
applying the remedies on the next page.

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

SOME GENERAL ASSEMBLY AND/OR CONSTRUCTION HINTS

Without a doubt the fastest, easiest, and most enjoyable way to develop practical electronic skills is by building a project or kit. Basic assembly and/or construction hints have been given in this handout to assist you in becoming a "super" builder. Use these suggestions when ever possible.

Chassis Wiring or Hand Wiring

- Secure wires and leads so they are positioned neatly and lay flat against chassis.
- Cut component wires to proper length before installing.
- Use insulating tubing (spaghetti) on all wires that may touch each other or could touch the chassis.
- Wrap wire around the terminal before soldering. Merely inserting the wire through the hole or slot does not make a satisfactory connection.
- As a general rule, when preparing hookup wire for connectio 3/4" of the insulation should be removed from each end.
- In order to avoid breaking internal connections when stripp insulation from the leads of components, hold the lead with pliers while it is being stripped.
- The leads on components are usually longer than needed to complete the connection. Trim the lead for proper length before making the connection for soldering. As a rule, a lead should be just long enough to complete the connection.
- If the wire is stranded, make sure to twist the individual strands tightly and tin before inserting them into the terminal.
- Components should be placed in a manner that allows their value to be read without moving the part around.
- Cut off any excess component lead or wire from terminals after they have been mechanically secured.

Name: ____________________

Date: ____________________

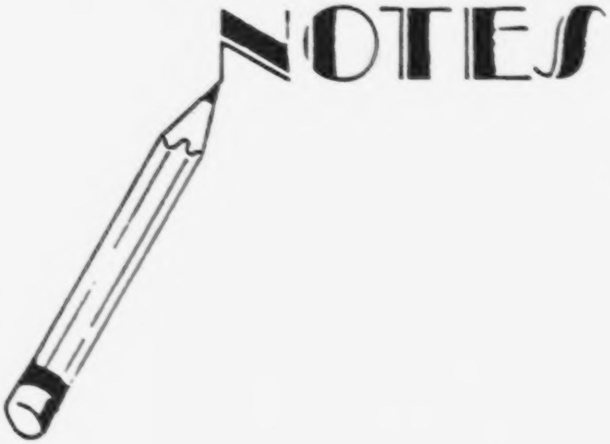
Period: ____________________

(SOLDERING ERROR)		(REMEDY)
● Not enough solder used	→	Apply more solder
● Too much solder used	→	Remove excess and reflow
● Improper heat application	→	Reheat and remove solder, then reflow

Desoldering Process:

Sometime you will have to remove soldered wires or parts from a chassis or printed circuit board, to do this the components must first be desoldered. Desoldering is basically the reverse action of the soldering process. Study the list below of procedures that you should follow each time you desolder.

- Obtain tools and materials
- Plug iron in and clean tip
- Tin the tip
- Keep tip damp with sponge
- Grasp wire or lead
- Apply heat
- Apply pressure / use solder removing tool
- Remove part
- Visual check/clean up



SAFETY

① When "resting" a soldering iron always use a soldering iron holder or stand.

② Always hold a soldering iron by its handle and when reaching for it be alert and never accidently grab the "hot" tip.

③ Do not splash hot solder around by shaking the iron when soldering or desoldering.

Name: ____________________

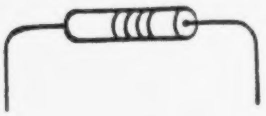
Date: ____________________

Period: ____________________

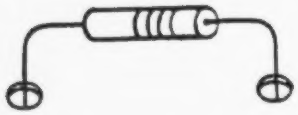
PC Component Mounting

- In wiring or soldering to printed-circuit boards, make certain there are no solder tails crossing over from one printed electrical path of copper to another.
- Avoid overheating the printed circuit copper. A soldering pencil or small iron (approximately 30 watts) is ideal for use in circuit board work.
- Holes that have been drilled on a PC board should be slightly, larger than wire or component lead to be utilized.
- PC components should be positioned flush against the circuit board when possible.
- Insert components or wire to stick out, if possible, about 1/16 to 3/32 of an inch on copper side then bend flat and solder. Watch out, don't use to much heat when soldering!
- A simple procedure, that improves the overall looks of your PC board, is to position all resistors so their coded value can easily be read in a glance from left to right.

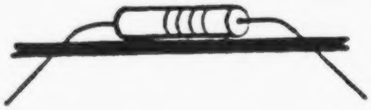
DETAIL VIEW OF COMPONENT MOUNTING ON PC BOARD



1. BEND LEADS

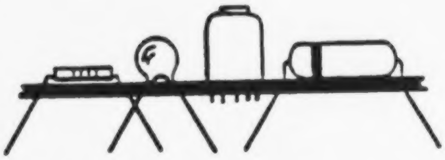


2. INSERT LEADS THROUGH PROPER HOLES FROM NONCOPPER SIDE OF PRINTED CIRCUIT BOARD



3. POSITION COMPONENT NEXT TO PRINTED CIRCUIT BOARD AND BEND LEADS TO HOLD IN PLACE

4. PROPER PLACEMENT



SAFETY

Remember, safety is of prime concern during all aspects of the building process. GOOD LUCK!

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

ELECTRICAL CONNECTIONS

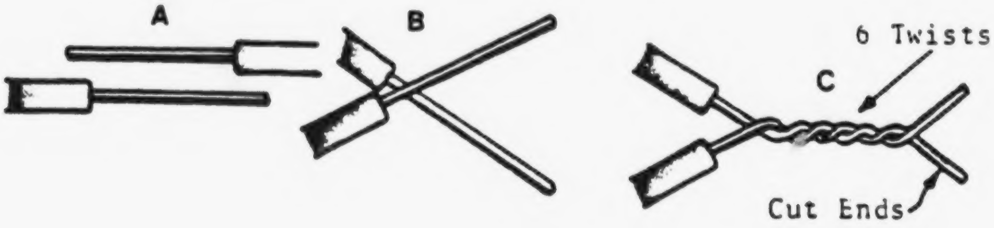
Electrical connections and electrical circuits must be reliable, and part of this reliability requires the individual who is wiring and soldering to be skillful. Use these sheets to help you master some basic wiring techniques, but remember it takes a great deal of practice to learn a skill, so lets get started!

Note, making hand-formed wire connections are called splices, the three most commonly used are as follows: Rat-Tail, Tap or Tee, and the Western Union.

3
Common
Splices

Rat-Tail:

This splice is generally used where wires are to be joined together. The Rat-Tail joint is commonly placed or used in an electrical junction box, like the ones in your home. This splice should be soldered and taped, or a solderless connector (wire nut) used, before the box cover is replaced. Note, if wire sizes below AWG 14 are used the splice can no longer be formed by hand. Use pliers for twisting and be carefull not to damage the wires. Follow the examples below when making this splice.



..................then solder and t.

Tap or Tee:

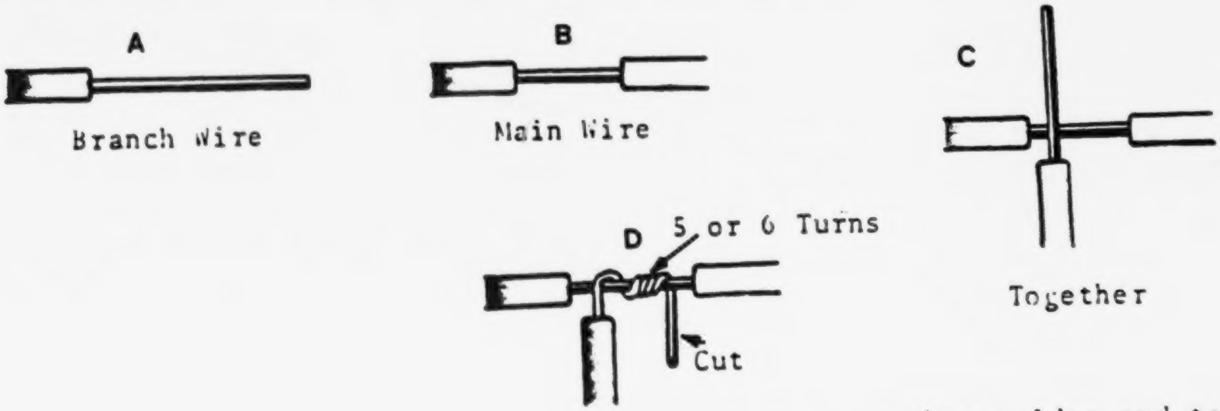
This splice is also used primarily in home electrical wiring circuits. The Tap splice is used when you want to connect a branch conductor to one wire that "runs through" a junction box. The advantage of this splice

Name: ______________________

Date: ______________________

Period: ______________________

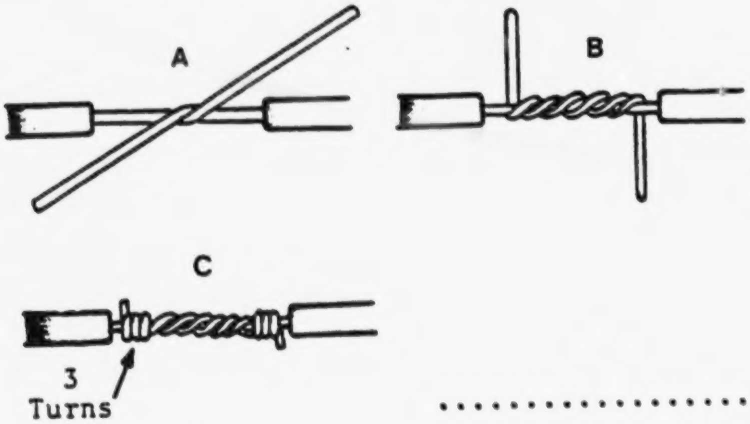
is that the main wire is not cut, just stripped where the branch wire is joined. This splice should be soldered and taped, before the box cover is replaced. Follow the examples given when making this splice.



...................then solder and tape.

Western Union:

This splice is the strongest of the three presented here and the most interesting one to make. It is used for splicing a broken/cut wire in a long wire or to extend a wire a few more feet if it is short. This splice should be soldered and taped when completed. This splice has a unique piece of history attached to its name. When the Western Union Telegraph Company had problems with breaks in telegraphic wires their workers would use this splice to repair the wire.



...................then solder and tape.

Solderless Connectors

Wire Nuts:

Solderless connectors or wire nuts can be used generally to splice wires up to size #6 AWG. The most common solderless connectors are the twist-on variety. This electrical hardware item is handy when one does not

Name: ____________________

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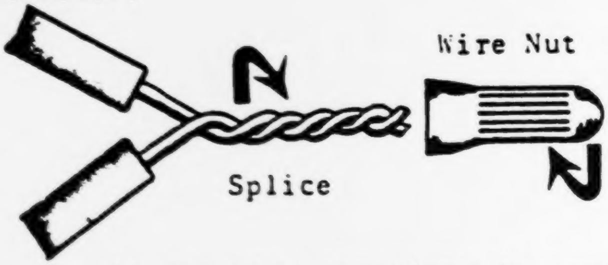
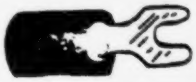
Period: ____________________

have the opportunity to solder or when the need of a quick yet strong mechanical electrical connection is necessary. Follow the example below when using this kind of connector.

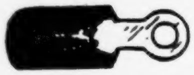


Solderless Terminal Lugs:

Solderless or crimp type terminals are used sometimes in projects as a means to provide a strong metal-to-metal bond (terminal-to-wire) without the use of the soldering process. Two common types are generally used, they are the Fork and Ring tongue styles.

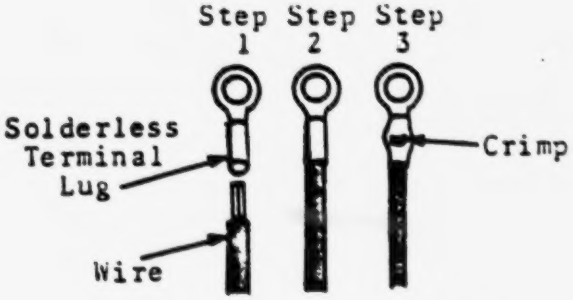


Fork Tongue

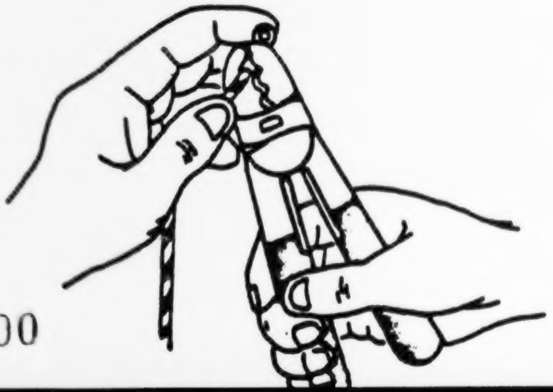


Ring Tongue

The style selected depends on your specific use, and to connect either o to wire requires a crimping tool. Check the example below for proper instalation technique.



Step 3 utilizes this kind of crimping tool

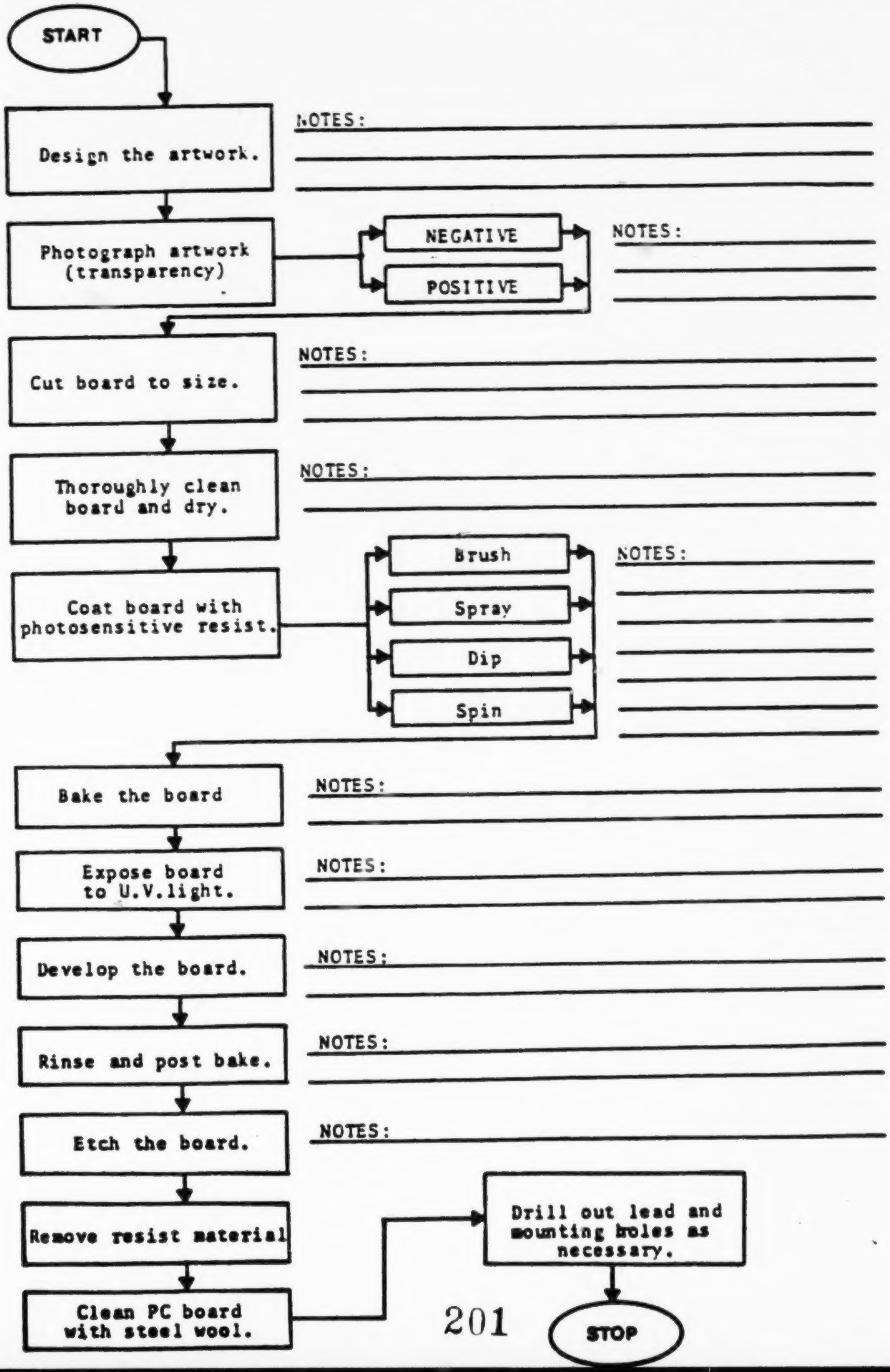


Name: ______________________

Date: ______________________

INFORMATIONAL HANDOUT Period: ______________________

PRINTED CIRCUIT BOARD FABRICATION - PHOTOGRAPHIC METHOD


START
Design the artwork.
NOTES:
Photograph artwork (transparency)
NEGATIVE
POSITIVE
NOTES:
Cut board to size.
NOTES:
Thoroughly clean board and dry.
NOTES:
Coat board with photosensitive resist.
Brush
Spray
Dip
Spin
NOTES:
Bake the board
NOTES:
Expose board to U.V.light.
NOTES:
Develop the board.
NOTES:
Rinse and post bake.
NOTES:
Etch the board.
NOTES:
Remove resist material
Clean PC board with steel wool.
Drill out lead and mounting holes as necessary.
STOP

SOLDER PRACTICE PROJECT # ____

NAME ______________________
DATE ____________ PER AM/PM

GRADE ☐

NFORMATION

LIST TWO TYPES OF WIRE — DESCRIBE EACH

1. SOLID WIRE - ______________________
2. STRANDED WIRE: ______________________

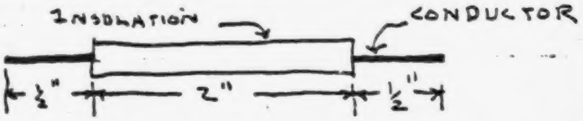
SOLDER - USE ANY RESOURCE TO FIND OUT WHAT SOLDER IS.

1. ______________________
2. ______________________
3. ______________________
4. ______________________

TINNING

1. WHAT IS TINNING? ______________________
2. LIST USES OF TINNING
   1. ______________________
   2. ______________________
   3. ______________________
3. Why Tinning? ______________________

PROJECT ______________ sig. DATE ______



TIN SOLDERING IRON ______ ______

TIN WIRE - ATTACH WIRE IS SPACES PROVIDED. (USE TAPE)

AWG	TINNED SOLID WIRE	AWG	TINNED STRANDED WIRE
___		___	
___		___	
___		___	
___			

SOLDER PRACTICE PROJECT # ___

NAME ___

DATE ___ PER. AM/PM

GRADE ☐

	SOLID WIRE		STRANDED WIRE
RAT TAIL SPLICE	AWG ___	___	AWG ___
RAT TAIL SPLICE	AWG ___	___	AWG ___
TAP OR TEE SPLICE	AWG ___	___	AWG ___
TAP OR TEE SPLICE	AWG ___	___	AWG ___
WESTERN UNION SPLICE	AWG ___	___	AWG ___
WESTERN UNION SPLICE	AWG ___	___	AWG ___

SOLDER PRACTICE PROJECT * ____ NAME ____

DATE ____ PER. AM/PM

GRADE ☐

INFORMATION (USE ANY RESOURCES IN THE ROOM.)

RESOURCE: DEFINE:

____ PRINTED CIRCUIT BOARD - ____

____ RESIST - ____

____ TRACE - ____

____ HEAT SINK - ____

____ FLUX - ____

____ DESOLDERING TOOL: ____

PRINTED CIRCUIT BOARD PROJECT

STEP #1. WRITE IN YOUR P.C. BOARD NUMBER ☐

STEP #2. REMOVE ALL OLD WIRE AND SOLDER FROM YOUR P.C. BOARD. CLEAN ALL SOLDER PADS AND TRACES.

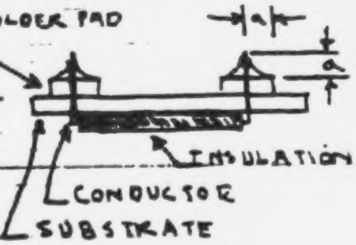
STEP #3 HAVE INSTRUCTOR INSPECT AND GRADE

GRADE ☐ SIGNATURE ____

STEP #4 INSTALL TINNED STRANDED HOOKUP WIRE IN EACH OF 20 SOLDER PADS. SEE DIAGRAM

STEP #5. HAVE INSTRUCTOR INSPECT AND GRADE.

GRADE ☐ SIGNATURE ____



STEP #6 REMOVE ALL WIRE. DO NOT OVERHEAT THE SOLDER PADS. SIGNATURE ____

⊛ NOTE: 1. NO MELTED INSULATION.
2. BEND CONDUCTOR TO A RIGHT ANGLE.

UNIT EXAM

BASIC ELECTRICAL SKILLS

IMPORTANT:

INDICATE YOUR ANSWERS ON THE ANSWER SHEET ONLY. FILL IN THE BOX CORRESPONDING TO THE CORRECT ANSWER TO EACH QUESTION, THERE IS ONLY ONE CORRECT ANSWER FOR EACH QUESTION.

1. Wire strippers are used to remove the conductor from wires. (T-F)
2. A stranded wire is less flexible than a solid wire of the same gauge. (T-F)
3. Side-cutting pliers are sometimes called lineman's pliers. (T-F)
4. A handpunch or chassis punch is used to make round holes in sheetmetal. (T-F)
5. The preferred solder to use in electronic project construction is 60/40 solder, rosin-core. (T-F)
6. A dull-colored solder joint, on a PC board, is acceptable as long as enough solder is used. (T-F)
7. A wire being soldered to a lug is usually first loosely fastened to the lug to hold it in place.
8. Conductors or traces on a printed circuit board often cross or over-lap. (T-F)
9. Drilling holes in sheetmetal can be a dangerous operation. (T-F)
10. A chassis forms the base upon which a circuit is assembled or mounted. (T-F)
11. Diagonal cutting pliers are designed for strippin wires. (T-F)
12. Pre-tinned hook-up wire is coated with a thin layer of tin to prevent the copper wire from oxidizing. (T-F)
13. Long-nosed pliers are designed primarily for holding and bending smal gauge wires. (T-F)
14. Do not move or handle a newly soldered wire until the solder has solidified sufficiently. (T-F)
15. A 24 gauge wire has a larger diameter than a number 12, American Wire Gauge wire. (T-F)
16. Magnet wire is most often insulated with a coating of enamel or lacquer. (T-F)
17. The job of removing solder from a terminal or PC joint is done with an unsoldering tool. (T-F)
18. Sheetmetal can be cut with tin snips, aviation snips or the box and pan brake. (T-F)

19. A phillips head screw can be driven by either a standard blade screwdriver, or a Phillips screwdriver. (T-F)

20. The process of coating a wire, terminal, or soldering iron tip with a thin layer of solder is called ____________.

21. Solder used for electronic work is usually in wire form and contains one or more cores of ____________ ______________.

22. The joining together (twisting) of two or more wires to form a permanant connection is called a ________________.

23. When soldering components which are sensitive to heat, a tool called a ______________ ______________ should be used.

HAND TOOLS / SOLDERING

ADJUSTABLE WRENCH :	một loại khoá mở phần tận cùng các tán Lục giác (mõ lết) Có hãm điều hoà rộng - hẹp.
ASSEMBLY :	Ráp các bộ phận điện.
AVIATION SNIPS :	Kéo dùng để cắt các tấm Kim loại nó có cần kép ở giữa 2 gọng để điều hoà việc cắt.
BALL - PEEN HAMMER :	loại búa có đầu tròn và đầu bằng
BOX AND PAN BRAKE :	loại máy xử dụng để cuốn cong các tấm Kim loại lớn có 1 bàn đạp và các ngón tay điều chỉnh để uốn cong từ 180° đến 40°.
CABLE TIES :	dây thắt bằng ni-lon dùng buộc các dây điện lại thành nhóm.
CENTER PUNCH :	cây đục dùng để làm dấu trên tấm kim loại trước khi khoan lỗ. (đầu nhọn 60°).
CHASSIS :	khung xe, khung máy bằng kim loại Tập trung dây mát.
CHASSIS PUNCH :	Một dụng cụ dùng để đục lỗ trên board (có thể đục lỗ tròn, ban nguyệt

COMPONENT : Các phần, bộ phận dùng để ráp vào mạch điện như Risistor, capacitor.

CONDUCTOR JOINTS : chỗ nối hai hay nhiều đầu dây điện (bằng cách hàn, vặn lại với nhau, ... có nhiệm vụ tải điện).

DESOLDERING TOOL : dụng cụ dùng để hút chì (hút để dời khỏi sự gắn chặt).

DIAGONAL- CUTTING PLIERS : loại kềm mỏ ngắn dùng để cắt dây kim loại mềm.

DRILL PRESS : khoan bàn có Tay điều hoà.

ELECTRICAL CONNECTION nối dây điện, vặn lại và chảy chì lên chỗ nối.

ELECTRICAL TAPE: băng keo cách điện dùng để quấn bên ngoài chỗ nối dây.

ETCHING : một phương pháp dùng a-xít ăn mòn lớp đồng trên board.

FILE : cây dũa (gọt mòn các góc, cạnh của board).

FLUX : phương pháp tẩy oxy bám trên mặt board giúp cho các điểm hàn trên board sạch và ăn chì tốt.

GAUGE : Cỡ dây điện. cỡ số nhỏ thì có đường kính dây lớn. Dây có số càng nhỏ thì đường kính càng lớn.

HACKSAW (cưa sắt)	:	loại cưa cầm tay dùng để cắt kim loại.
HAND PUNCH (giống như kềm bấm lỗ giây nịt)	:	Dùi tay, dùng để dùi lỗ tròn ½ inch.
HARDWARE	:	chỉ vật dụng về điện, cơ khí như bù loong, con ốc... công tắc, cầu chì...
HARNESS	:	bó dây buộc với nhau.
HEAT SINK	:	một loại dụng cụ dùng để kẹp vào chân các diode, LED, CAPACITOR... khi hàn (để hút nhiệt có thể làm thiệt hại các component trên).
HEAT SHRINKABLE TUBING	:	Ống nylon hay cao su để giữ dây điện. Dùng hơi nóng nó sẽ co lại và giữ chặt nhóm dây.
INSULATION	:	Chất cách điện hay vỏ bên ngoài dây điện.
LONG-NOSE PLIERS	:	Kềm mỏ dài dùng để uốn cong và cắt dây điện.
MAGNET WIRE		dây đồng dùng quấn xung quanh lõi sắt trong bộ cảm điện, biến thế ... nó có chất cách điện bao bọc bên ngoài. Khi xử dụng nối phải cạo chất cách điện ở 2 đầu dây.
NUT DRIVER	:	dụng cụ có đầu lục giác dùng để chụp lên đầu con tán lục giác để vặn tháo - ráp.

OPEN END WRENCH: chìa khoá miệng có 2 đầu.

PORTABLE ELECTRIC DRILL : Khoan điện tay.

PRINTED CIRCUIT BOARD : In mạch điện trên board.

RESIST : chất kháng, dùng xịt trên board, sau khi đặt lên hệ thống rọi ánh sáng rồi đưa vào chất phát triển phần bị che ánh sáng sẽ được giữ lại thành mạch điện trên board.

SCREWDRIVER : Vít vặn ốc gồm 2 loại.

common screwdriver: vít vặn ốc khe ngang .

Phillip screwdriver. Vít vặn ốc khe chữ thập

SIDE CUTTER PLIERS: Kềm cắt cạnh board.

SLIP JOINT PLIERS: Kềm mỏ quạ hàm răng có thể nới rộng.

SOLDER : chì hàn có 2 loại
loại 40% chì + 60% thiếc nóng chảy ở 370°
loại 37% chì + 63% thiếc nóng chảy ở 390°.

SOLDERING IRON: mỏ hàn chì.

SOLID WIRE : dây cứng

STRANDED WIRE . dây mềm

TAPPERED HAND REAMER: một loại cạo có đầu nhọn từ nhỏ lên dần dùng để nới rộng lỗ.

TINNING : chảy chì lên chỗ nối dây điện hoặc chảy chì lên đầu dây điện

TIN SNIPS . Kéo cắt giấy kim loại

TWIST-ON CONNECTOR : Sự nối dây bằng cách vặn các đầu dây lại không hàn chì.

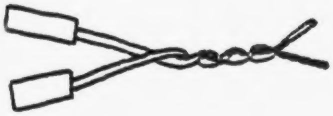
TWIST DRILL: mũi khoan.

VISE : cái ê-tô: một dụng cụ đặt hoặc gắn trên bàn có 2 ngàm và 1 tay quay. Dùng để giữ vật giữa 2 ngàm.

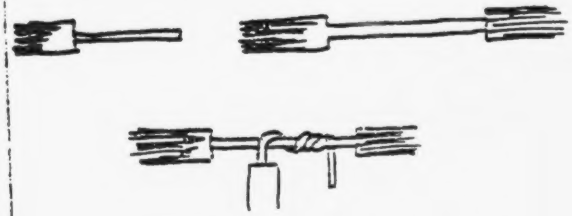
WIRE STRIPPERS: Kéo dùng cắt và bóc vỏ bên ngoài dây điện.

PC BOARD : Board đồng sau khi in và phát triển rồi nhúng vào a-xít các mạch điện còn giữ lại trên board để ráp các bộ phận điện.

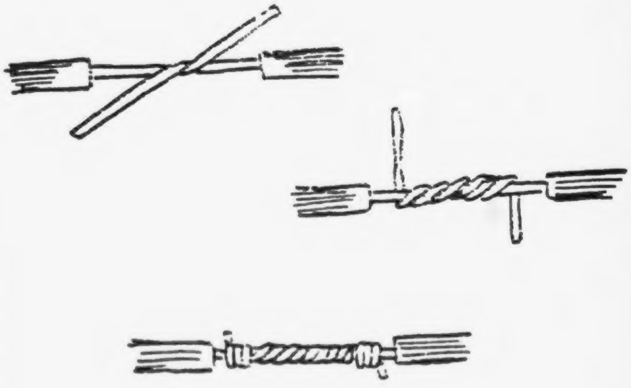
RAT TAIL : loại nối dây xoắn lại với nhau



TAP hay TEE:



WESTERN UNION:



工具使用(TOOLS USE)

III-U4-8

技術語彙

活动板手(ADJUSTABLE WRENCH)：附有可調開口大小的螺旋鉗
由一固定叉頭及一可調整(用大姆指旋轉的)之螺絲叉頭設計
成的. 使一个鉗子可用於不同大小的螺帽(nut)或螺釘(bolt)

组合(ASSEMBLY)：使用有效或必須之工具將零件组合在一起成一完
整的設配.

航空剪(AVIATION SNIPS)：附有複合槓桿(compound lever)的金屬
片裁剪刀, 可減少裁剪的用力。

球形鎚子(BALL-PEE HAMMER)：一般鉄工用的鎚子, 一端为平面鎚
頭, 另一端為圓球形用以鎚鉚釘。

箱及盤型匣(BOX AND PAN BRAKE)：附可調间距彎金屬板的重型工
可以内彎或外彎 180度至40度角度.

电线紮带(CABLE TIES)：尼龍帶具有鎖緊的帶鈕, 是用以將許多电
线鈕綁在一起.

冲子(CENTER PUNCH)：60度尖頭的金屬打孔器. 用來在要鑽孔的
点上做記号以防鑽頭打滑.

底盤(CHASSIS)(基架)：將各重要配件或电路附着在上面的一种
金屬盒或框架.

基架打孔器(CHASSIS PUNCH)：金屬打孔器. 用以打直径½"至3"
圆形孔, 两个剪鈌是由螺絲鎖在一起, 為基架打孔器也有
鑽方型孔, 鑰匙型孔或半圆型孔的剪鈌頭.

组件(COMPONENT)：电子零件的通称, 基本电子零件的电阻器
(resistor)电容器(capacitor)两極管(diode)晶体管(tran

sistor）均可歸類為组件（Components）.

導体連接（CONDUCTOR JOINTS）：把兩條以上的电线雖实地接連在
一起的方法，一個完滿的導体接連是具備：
1.）机械確实接合 —導线緊密捲纏在一起.
2）电氣確实接合 —能允許电流自由通过.
3）.被認可的绝缘物包覆。

除焊劑工具（DESOLDERING TOOL）：除去導线或接連点上　溶的
焊劑之工具，大部份此种工具是以抽真空或吸氣的力量將焊
劑抽掉.

斜口鉗（DIAGONAL CUTTING PLIERS）：剪軟金属线的鉗子，有兩類
型，其一為斜口型，另一為滿型.

鑽孔机（DRILL PRESS）附有台面的一种鑽孔或搪孔用帶有
達的工具，鑽頭是用掐子（chuck）鎖緊，轉动進鑽頭把
手進行鑽孔。

电気性連接（ELECTRICAL CONNECTION）：一种連接兩條導线使
一條連續电线般而使电流有效地通过，一個好的电気連
接是要求电线必須绝对清潔以及確实捲纏在一起以達
到良好接觸，通常在接点處加以焊接以達优良电気接合

电器膠带（ELECTRICAL TAPE）：一种黑色塑膠绝缘膠带，用來包
捲曝露的連接点，

腐蝕（ETCHING）：用化学方法除去电路板上不需要的銅金属膜，一
般腐蝕液為过硫酸銨（Ammonium persulfate）或氯化鐵
（ferric chloride）.

銼刀（FILE）：用來磨平金属片边缘或小型切割磨尖的一种工具.

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助焊剂(FLUX)：当焊接時除去氧気及清潔銅面上輕微氧化的一种
化学药剂。具有助於良好焊接效果。在電器界多用松香(rosin
焊助剂，呈糊狀或呈柱狀放在焊條内。

尺規(GAUGE)：测定电线粗细的一种標準系统。尺規大小以數目表
示，如24度(号)(24 gauge)或24g。數值愈小，电线直径愈大

弓鋸(HACK SAW)：用以切割金属的一种手鋸，弓鋸向前推進才有切割效果

手动打孔器(HAND PUNCH)：可鑽约直径 ½"孔的金属片打孔器，其具
有一组不同直径大小模頭(die sets)及固定框.

硬体(HARDWARE)：物品被設計能提供实物或电器的支架。实物
架硬体如螺絲(screw)，螺釘(bolts)，夾子(clamps)螺帽
(nut)及襯墊(spacers)，电気硬体如開関(switches)
燈(lamps)、插座(sockets)、保險絲(fuses)及接线端子
(terminals).

束合(HARNESS)：将許多單股电线整齊地聚合在一起成一束电
典型的束合是在不同位置有許多电线经过而将其捆成一

热散发器(HEAT SINK)：一种小金属工具用以刹射组件或接点
在焊接時所受的热以防其損坏。

热收缩軟管(HEAT SHRINKABLE TUBING)：可套在連接点的绝缘
軟管，当用热風槍、火柴或焊槍去热它時，则会收缩而緊
包着接点.

绝缘物(INSULATION)：可包在導线或接点外的物质，用以防
止導线短路或突然的电击。

分编(LACING)：沿着电纜将多股电线一联串分别歸類捆绑

3

在一起的一种扣帶。

長嘴鉗(LONG-NOSE PLIERS)：用来弯或剪尖电线或夹小東西的鉗子．一般上尚附有小的剪虎边可剪断细电线．

磁线(MAGNET WIRE)：用在纏繞线圈，小变压器及继电器．此种磁线外塗有一層透明的釉或洋漆．

机械性接連(MECHANICAL CONNECTION)：以纏绕或弯捲方法連结电线止端子或另一电线，即使不焊接也很牢固．

螺帽起子(NUT DRIVER)：能很快地固定或取出螺帽的工具．其設計能与螺絲起子把手組合在一起．

開口板手(OPEN-END WRENCH)：一般用途的板手．两端均有不同大小尺寸的開口．

輕便电鑽(PORTABLE ELECTRIC DRILL)：手提式动力电鑽．用以在不同物体上鑽孔．用掐子(chuck)鎖緊鑽頭，在把手上有板机(trigger)開関．

印刷电路板(PRINTED CIRCUIT BOARD)：附有一層銅膜導体的基板，在基板上鑽有小孔以插入所需之电子組件並与此層銅膜焊接固定。銅膜线跡(foil traces)即有如电路的連结線．

阻抗(RESIST)：在印刷电路板製作時．塗在銅膜上的一种物質以畫出銅线跡。

螺絲起子(SCREW DRIVER)：利用扭力将螺絲固定或取出的工具．一般有溝槽型端頭(slotted or 標準型端頭 standard)或十子型端頭(Philips head)

迵剪鉗(SIDE CUTTER PLIERS):用以纏緊及剪断較粗的电线的一种重力工具.

滑接鉗子(SLIP JOINT PLIERS):一种用以纏緊或纏繞的普通工具,其滑动接点使鋏口可以闭大。

焊條(SOLDER):錫,鉛合金,受热融在电氣接点以增加电導性,加強机械性接連及防止氧化。在电器上一般用60%的錫,40%的鉛合金條中心有松香柱。其熔点為370°F具有良好的机械強度及可快速焊接。

焊接(SOLDER JOINT):在接頭,接点上處理清潔,加热置於適量焊剂的过程謂之。

焊槍(烙鉄)(SOLDERING IRON):附有热尖頭(heated tip)以传热至接点焊接的工具.在电器使用一般称作焊筆(pencil iron),其功能為25瓦特至40瓦特之间.

非焊接结連器(SOLDERLESS CONNECTOR):設計的端子或夾頭,不用焊接而結連導体的一种配件.如導线插入接綫片(lug)要用特别工具将其鉗扁以固定並達电気結連。

实线(单线)(SOLID WIRE):通常包有绝缘物的单股導线.

结线(SPLICE):将两條以上導线接在一起的方法謂之。
如有:分叉(T型)结线法(Tap or tee splice)
线端交叉结线法(rat-tail splice)
直线形(西方联合公司)结線法(Western Union splice)

直迵斬切机(SQUARING SHEAR):用以切剪金屬片,其位置固定的一种机器。其切刀的动作是用脚踏板或平衡手桿操

LII-U4-11, -12.

多股絞合线 (STRANDED WIRE)：許多股细电线纏合在一起，外包有绝缘物的導线，粗细相同的絞合线比实线要柔軟。

擴孔錐 (TAPPERED HAND REAMER)：T型錐頭工具，用以擴大金屬片上的孔径。

鍍錫 (TINNING)：用焊劑清潔塗抹的方法。一般指在焊槍热尖頭上抹鍍焊劑，在導线，端子，印刷电路板及电子組件引线上通常均已鍍錫，以便進行电氣性接連。

錫剪 (TIN SNIPS)：用来裁剪金屬片的剪刀。

电路軌跡 (TRACE)：留在印刷电路板上的銅膜痕跡。此銅膜线跡即為电子組件之间的導线。

絞結器 (TWIST-ON CONNECTOR)：用在導线端頭交叉结线上。附有绝缘物的一种接合器。將其套入相平行的裸线頭，然後扭絞则兩线端頭就緊密结合。

螺紋体鑽頭 (TWIST DRILL)：用碳鋼製成的鑽頭 (drill bit) 用以在金屬片上鑽孔。其用在鑽孔机或手提式电鑽。

虎頭鋏 (VISE)：以固定要鑽孔，切割，接焊的物品的夾具，最普遍的為固定在平台面上的虎頭鋏。有許多類型的虎頭夾被使用在电子業操作上。

剝线器 (WIRE-STRIPPERS)：用以剝掉包在導线上绝缘物

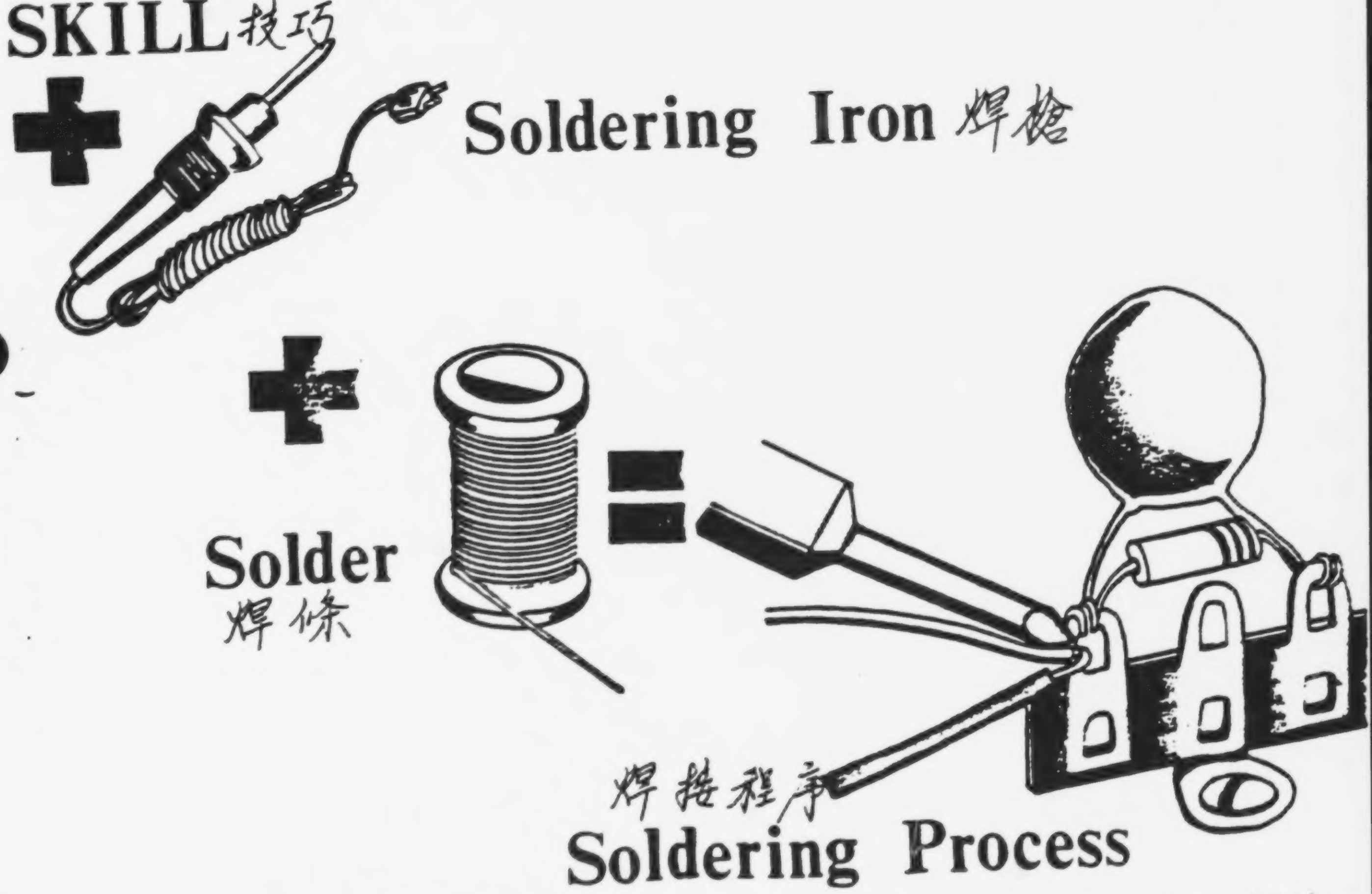
小工具。

LII-U4-22

焊接4步驟（A 4 STEP GUIDE TO SOLDERING）

简介：何謂焊接（what is soldering?）

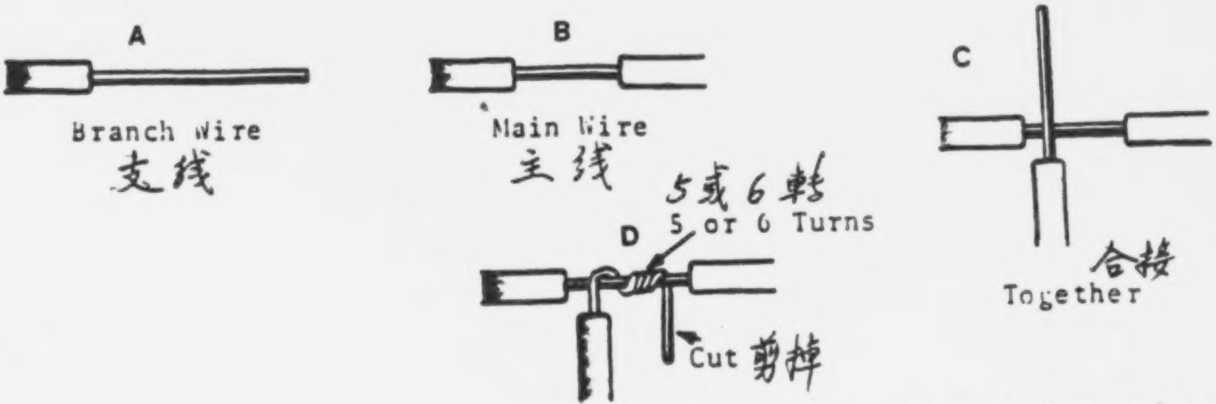
在电器及电子業工作，良好品质的焊接是十分重要的，以机械及电器方式用焊條（solder）及加热器：焊槍（solder iron）将金属物（導线，组件引线等）具有机械性（mechanically）及电器性（electrical地结連在一起謂之焊接。


SKILL 技巧
Soldering Iron 焊槍
Solder
焊條
焊接程序
Soldering Process

焊接必须能使接合處長久保有电性结合，良好焊接也可以得到：------

- 防止生銹腐蝕
- 增加结合強度

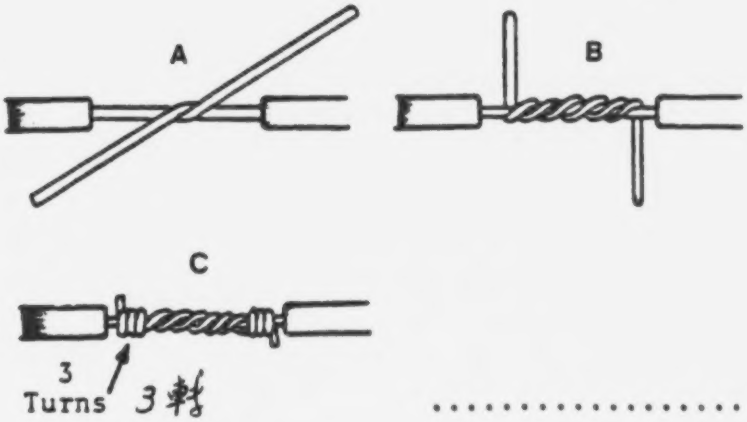
LII-04-28


A
Branch Wire
支线
B
Main Wire
主线
C
合接
Together
D
5或6轉
5 or 6 Turns
Cut 剪掉

..................then solder and tape.

直线法（西方联合公司法）(Western Union)

此法是最紧固及有趣的结法，用在长導线断线連结或要再
接數此長度，結线段要焊接及包膠帶，其名称由来是当時西方联合
电报公司的工人结連他们公司断线的电报導线時用的方法。


A
B
C
3
Turns
3轉

..................then solder and tape.

无焊接结連

导线螺帽 (wire nuts):

无焊接结連或導线螺帽用至導线粗至 AWG 6号线，最普通
是用絞接擠擰器 (twist-on variety)，当你没有机会焊接或要很快結
完畢時用的一种紧固的机械式电器结法。

LII-U4-23

① 选择焊接工具及材料

永遠选用正確的工具及材料達成工作.請記住,正確使用工具及材料可以提高你的技巧及工作品质。当預備焊接前查下列物品:

□ 安全眼鏡
□ 適当的焊槍及熱尖頭
□ 松香焊條60/40
□ 助焊劑
□ 除焊劑器/裸线带(braid)
□ 湿海棉
□ 其他手工具
□ 虎頭鉗,

② 焊接程序:

良好的焊接技巧是需要学習的,而最好的学習方法就是練習(practice),每次焊接時要依下列程序去做:

提得工具及材料
焊槍插电及清熱尖頭
热尖頭鍍錫
預備要焊的零件
做机械性结合
保護热敏感的组件
置用焊條
不要搖动组件
目視檢查

③ 檢驗:

立即檢查你工作結果以防不良的焊接.不良品一般是三"种
问题存在。利用下頁的矯正方法,你就能解决這些问題.

錯誤焊接(SOLDERING ERROR)　矯正(REMEDY)

- 焊剂置用不夠 ——→ 多用些
- 焊剂置用太多 ——→ 除去一些,再焊
- 不適当地加热 ——→ 再加热,除去焊剂,再焊.

除焊剂的程序:

有時你要從基板或印刷电路板上取出導线或组件,則首先要除去焊剂.除焊剂的方法基本上是焊接过程的反步驟。每次你除焊剂時依下列程序去做:

取工具及材料
焊槍插电及清热尖頭
热尖頭鍍錫
用濕海棉保持热尖頭濕.
抓緊導线与组件引线
將热焊槍接觸接点(apply heat)
加压力/用除焊剂器
移開组件
目視檢查/清潔

安全

① 当不用焊槍時,焊槍永遠放在焊槍架上(soldering iron holder or stand)

② 握着焊槍柄,要小心,不要抓着热尖頭.

③ 当焊接或除焊剂時,不要甩动焊槍,使热的焊剂飛濺四處

LII-U4-25

组合及製作上一般提示

(SOME GENERAL ASSEMIBLY AND/OR CONSTRUCTION HINTS)

不可否認的，学習电子技術最快捷及最有趣的方法是去
做出某些成品。本章解述组合或製作上的基本技巧，使你成為
一个"傑出的"製造者。請儘量利用下列提示。

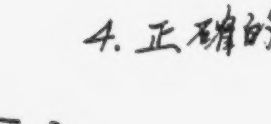
基板线路或導线线路（chassis wiring or hand wiring）

- 確实地将導线或组件引线正確接觸置於基板上。
- 在插置前先剪引线至適当長度。
- 用绝缘塑膠軟管套在所有会相碰或觸到基板的導线。
- 一般規定，導线以基板掛鈎的一端要去掉 3/4" 的绝缘外層。
- 当要剝掉绝缘物外層時用小鉗子夾住组件引线，以防将组
件内部破坏。
- 通常组件引线均比你需要的長度要長。在焊接前剪短引
至適当長度。一般規定其長度剛夠相接觸即可。
- 若是多股绞合线，则在插入端子（terminal）(基板孔)前先要将
股线纏緊密並鍍錫。
- 各个组件上之標示要向同一方向，以便認讀，而不须将基板
轉来轉去地讀。
- 当各组件以械机接合好後，将多餘長出来的引线剪掉。

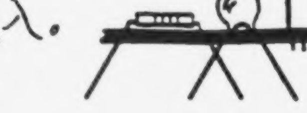
印刷电路板组件置位.(PC component mounting)

- 当接线或焊接至印刷电路板時,不可讓多餘的焊劑流出印刷电路銅膜跡线外.
- 避免印刷电路板过熱,用约30瓦特电能的小型焊槍或焊筆是理想工具.
- 印刷电路板上鑽的孔只要比组件引线大一点点即可.
- 组件儘量與基板高度相同(即将接觸基板)
- 将组件引线或導线腳頭插入基板孔,使其在有銅膜跡线面凸出 1/16~3/32 inch(英吋),将其彎平並接焊.
- 将所有电阻器數值表示環由左至右排列,使一瞄眼就可以看出其电阻數值。這也使印刷电路板整齊好看。

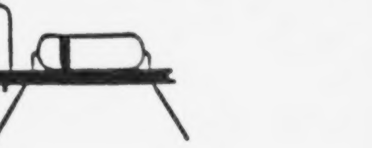
组件置於印刷电路板的细節討論:



1. 彎轉引线

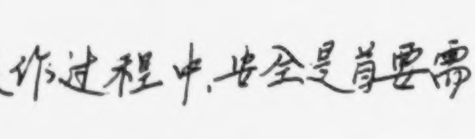


2. 将引线由無銅膜的一面適當位置孔插入。



3. 组件置觸及基板並彎曲组件之引线.

4. 正確的置入。



安全

記住:在任何製作过程中,安全是首要需注意的事。

LZZ-U4-27

电器接連(ELECTRICAL CONNECTIONS).

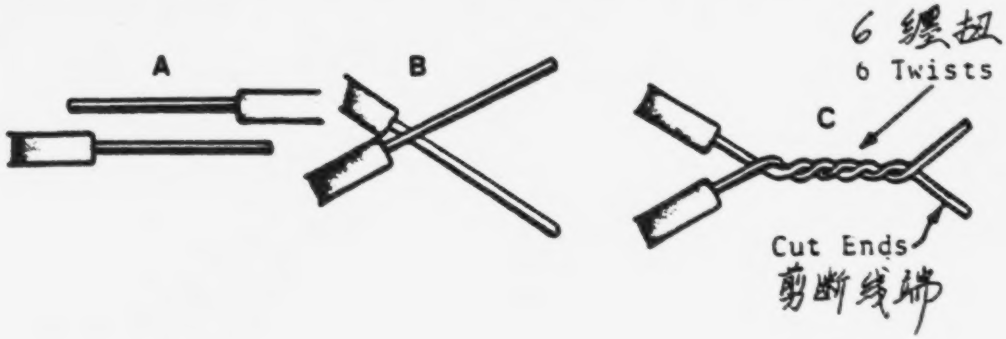
电器連结及电器路线必须可靠.這可靠性一部份依賴接线或焊接者的技術.這些講義可以協助你了解某些接线基本技巧,但記着,練習是学習技術最好的方式。现在讓我们開始吧

注意:用工具把电线接連稱之為"结线"(splice).下列三种中普通的结线方法是:线端交叉结线法(rat-tail splice),分叉(T型)结线法(Tap or Tee)及直线形(西方聯合公司)法(Western Union).

一般结线

线端交叉法(Rat-Tail)

多用在两條线端同方向而结在一起,如你家中电器接线箱中之电线頭之連结。在蓋上箱蓋前此种结連須加以焊接及加膠带或用非焊接结合器(導线螺帽 wire nut)。若導线粗细尺規小於AW 14 則須用鉗子將其纏结,但小心不要損伤導线。依下例練習纏结

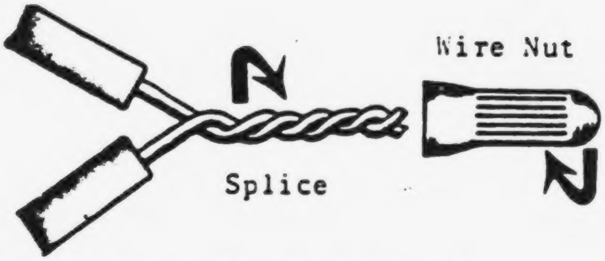


分叉法(T型法)(Tap or Tee)

在家庭电器路线上也是主要的结线方法。当你要由接线箱中一條導线接出一條支线時則用這种方法。此法的好處在不用剪断主线,只要剝掉接支线的那段线的绝缘物而已。在合上箱蓋前必須焊接及包膠带,依下例練習纏结。

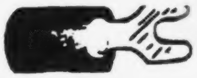
2II-44-29

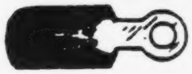
依下例结連:


Wire Nut
Splice

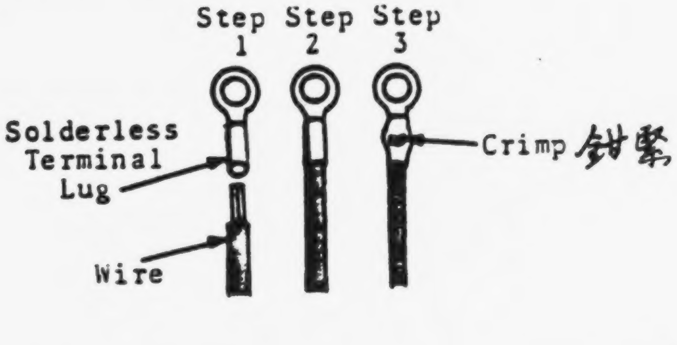
无焊接端子接线片(solderless terminal lugs).

无焊接(solderless)或摺缩(crimp)型端子有時被用在導线与金属端子结連處而无需再焊接,两种普遍型式為:义型舌片、另為環型舌片.

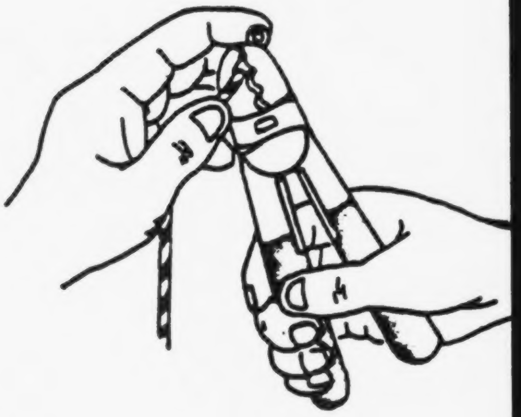

Fork Tongue
义型舌片


Ring Tongue
環型舌片

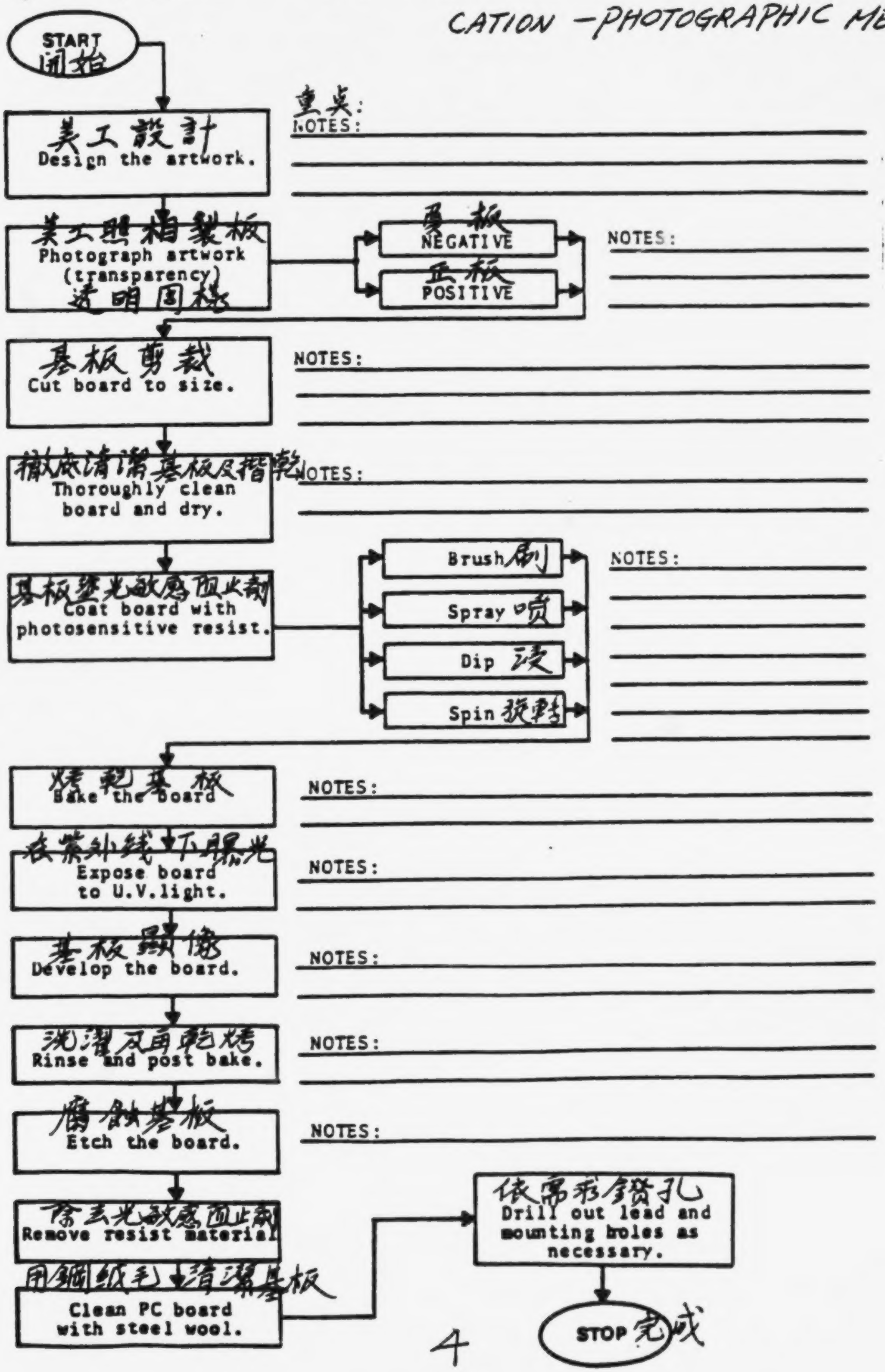
依你的特定用途而选擇型類,但均需用到摺缩工具鉗,
例查驗其緊固特性.


Step 1
Step 2
Step 3
Solderless Terminal Lug
Wire
Crimp 鉗緊

第3步.用此种鉗子鉗緊
Step 3 utilizes this kind of crimping tool



印刷电路板製作—照相法 (PRINTED CIRCUIT BOARD FABRICATION -PHOTOGRAPHIC METHOD)


START 开始
美工設計 Design the artwork.
重点: NOTES:
美工照相製板 Photograph artwork (transparency) 透明图样
负板 NEGATIVE
正板 POSITIVE
NOTES:
基板剪裁 Cut board to size.
NOTES:
彻底清潔基板及揩乾 Thoroughly clean board and dry.
NOTES:
基板塗光敏感阻止劑 Coat board with photosensitive resist.
Brush 刷
Spray 喷
Dip 浸
Spin 旋轉
NOTES:
烤乾基板 Bake the board
NOTES:
在紫外线下曝光 Expose board to U.V. light.
NOTES:
基板顯像 Develop the board.
NOTES:
洗潔及再乾烤 Rinse and post bake.
NOTES:
腐蝕基板 Etch the board.
NOTES:
除去光敏感阻止劑 Remove resist material
用鋼絲毛清潔基板 Clean PC board with steel wool.
依需要鑽孔 Drill out lead and mounting holes as necessary.
STOP 完成

ELECTRONIC CURRICULUM

VOCATIONAL TRAININ[illegible]ON PLAN # IV Meters and meter Reading

Teaching Materials Source ______
Chapter ______, pages ______
Lab Manual pages ______
Additional Instructor Materials ______

Main concepts student will learn:

1. To measure the voltage of a dry cell using a voltmeter.
2. To measure the voltage across the combinations which result from connecting dry cells in series and in parallel.
3. To connect a current meter to measure direct current in a circuit.
4. To measure the effect of resistance in controlling current in a circuit.
5. To measure the effect of voltage in controlling current in a circuit.
6. To determine the value of resistors from their EIA (Electronic Industries Association) color code.
7. To read the resistance value at a specified point on each of the chmeter scales on an electronic voltmeter.
8. To measure resistors of different values.
9. to measure the resistance across each combination of two of the three terminals of a potentiometer and to observe the range of resistance change as the shaft of the potentiometer is varied throughout its entire range.

Technical Vocabulary

Terms used to describe the functions of the meter and selected related parts. i.o.,

- scale
- polarity
- ranne
- meterface
- input jack
- test leads

Related General Vocabulary

Terms such as:

- infinity
- zero
- minimum
- maximum

Teaching Activity

Demo of reading scales.

Demo of meter use.

Demo of how to set up the circuits.

Demo of what can go wrong if the meter is used improperly.

Materials and Notes

Students are working with meters while they are also working on projects they began in Unit III.

Length of Lesson

2 weeks

Evaluation

Quiz - Written

Quiz - Lab performance

METERS

INFORMATION SUMMARY

The VOM is a very versatile instrument which measures, according to one manufacturer, 1001 different things. It requires no external source of power as many other meters do, and it is suited for use in both field and shop.

The VOM measures current, voltage, and resistance.

When measuring current, the meter must be connected in series with the circuit at the desired point, so that the positive meter lead is toward the positive side of the circuit and the negative lead is toward the negative side (observe polarity). The meter is set on the highest range of current to protect the meter. You must never connect an ammeter in parallel with any part of the circuit. Always connect the ammeter (current meter) in series so that all the current to be measured must flow through the meter.

When measuring voltage, the meter must be connected across (in parallel with) the part being measured, with the meter on highest voltage range for protection. The positive lead is placed toward the most positive terminal and the negative lead toward the negative side.

When measuring ohms, the circuit is first disconnected from any source of power to protect the meter. The resistor to be measured must then be disconnected at one end so only its resistance will be measured.

VOM's are designed to measure DC current, AC and DC voltage, and resistance. When used properly and carefully, the VOM can be one of the most effective tools in the shop. You should also be aware that if the meter is treated improperly, it loses its effectiveness as a precision measuring instrument.

INFORMATION

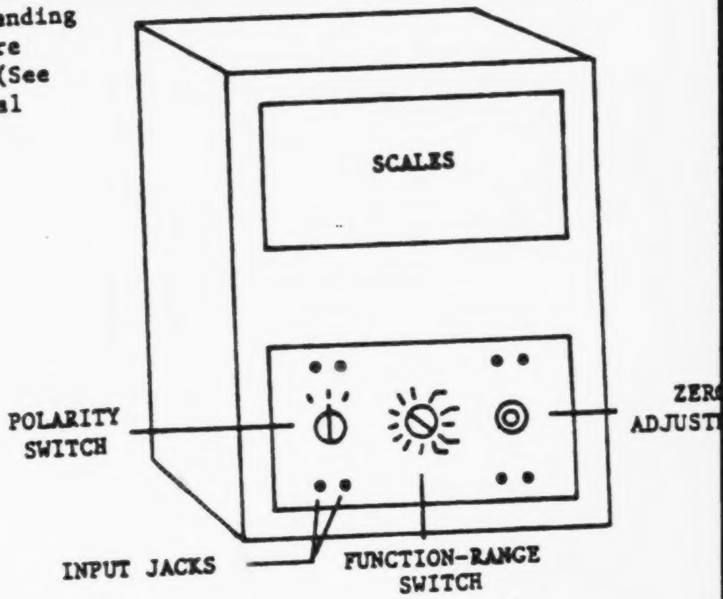
INFORMATION SHEET 1

GENERAL DESCRIPTION OF THE VOLT-OHM-MILLIAMMETER

Commercial models of the Volt-Ohm-Milliammeter (VOM) are able to measure direct and alternating voltages, direct current, and resistance. Additional functions are sometimes included.

Most VOM's have several features in common. These are:

1. POLARITY SWITCH - selects +DC, -DC, or AC depending on what it is you are going to measure. (See drawing for a typical example.)


SCALES
POLARITY SWITCH
ZER
ADJUST
INPUT JACKS
FUNCTION-RANGE SWITCH

2. FUNCTION-RANGE SWITCH - selects the function (current, voltage, or resistance) and the range to be measured (100 ma or 10 ma, etc.). Only one of the ranges can be selected at one time.

3. ZERO ADJUSTMENT - (sometimes called zero ohms) is a variable resistance in the ohmmeter circuit, and is used to adjust the meter when measuring ohms to allow for changes on the voltage of the internal batteries. It is adjusted with the range switch on any resistance range so the needle points to zero on the ohms scale (usually on the right side) when the leads are touched (shorted) together. The meter is adjusted to zero because at this time there is no resistance between the leads of the meter. This adjustment must usually be made whenever the resistance range is changed.

4. INPUT JACKS - are the places on the meter where the test leads are connected. They are all clearly labeled, and if there is any question as to their use, consult the Operator's Manual for specific information. Most measurements are made by using the + and - (common) jacks.

5. METER SCALES - are like a curved ruler, and are marked with small divisions from which values may be read.

6. TEST LEADS - are the wires that are used to connect the meter to the circuit under test. The red lead is considered positive (+), and the black lead is negative (-) or common. Connecting these leads correctly is called observing correct polarity. Incorrect polarity in DC circuits will cause the needle to deflect or move backwards, and damage could result. In AC circuits, polarity is not important.

All VOM's have one thing in common. They have a very sensitive meter movement. The meter's range and function is changed to measure various voltages and currents.

The VOM meter movement measures current flow. The movement commonly measures amounts of current less than fifty millionths of an ampere (.00005 A or 50 microamps). If the meters are not connected properly, they may be quickly damaged. ALL METERS ARE DESIGNED TO BE USED CORRECTLY! Each meter costs about $100. (You may be responsible for any damage through neglect or misuse.) The VOM will cause some current to be drawn from the circuit. Because of this, the meter is said to load the circuit. This loading becomes very noticeable in some circuits and is one source of error in measurements. Loading is most noticeable in high resistance circuits or when the meter is on a low range.

INFORMATION SHEET 2

General procedure for measuring voltage with a VOM is given below. This will fit the most common types of meters with few variations.

1. For the meter indications to be as accurate as possible, the needle should rest directly over zero on the left side of the scale when the meter is disconnected. If the needle does not sit directly over zero on the left, it should be adjusted only by someone who knows the proper method of setting the meter.

2. LEAD PLACEMENT - place the leads in the proper input jacks. The leads are connected red to positive (+), and the black to negative (-) or common.

3. POLARITY SWITCH - if your meter is equipped with a polarity switch, turn it to the position that represents the type of voltage you are measuring (AC or DC). If the voltage under measure is DC, have the switch on DC+ for measurements. The DC- is used only in special cases, as when you are measuring negative DC voltages. On meters that have "AC volts" and "DC volts" included on the range switch, be sure to select the cor ranges as well as the type of voltage.

4. FUNCTION-RANGE SWITCH - turn this switch to the highest voltage range. This step should be done when measuring any voltages, unless you are definitely sure that the voltage will not exceed the range voltage.

5. CONNECTING THE METER - always turn off the power when making a connection so as to provide for personal safety. The leads are connected across (in parallel with) the part of the circuit under test. In DC measurements, you connect the black lead to the most negative point of the circuit and the red lead to the most positive point. If you are unsure of the connection, consult your instructor.

6. CIRCUIT ON - if the voltage reading is within a lower range (in the lower ¼ of the scale), turn the range switch down until the needle moves above the ¼ scale mark. Be careful not to turn down more than one range step at a time.

7. After the reading has been made, turn the circuit off, remove the meter, and turn the meter to "OFF" or to the highest range to protect the meter.

General precautions should be followed with the VOM as with any other meter. Some of these are as follows:

> When measuring voltage, the circuit is necessarily alive, so keep one hand in your pocket. This is for safety. If you use two hands connecting the meter to a circuit, you are placing yourself in parallel with the circuit and in effect may have a short circuit through your body, which could provide an exciting turn of events. When electricity passes through your heart, it can, and probably will, cause severe shock and possibly death. Do not be afraid of electricity, RESPECT IT!

If the voltmeter were placed in series with the circuit, all of the current would have to go through the meter. Because the voltmeter has a very high internal resistance, it would measure voltage that was nearly equal to the supply voltage and would, therefore, give a false reading.

When measuring voltage, do not have the meter set to measure ohms or milliamps, as you will damage the meter.

Before proceeding further, do Experiment #1 on "Measuring Voltage With the VOM."

INFORMATION SHEET 3

MEASURING CURRENT WITH A VOM

When measuring current with a VOM, it is necessary to follow certain general procedures. Typical procedures for measuring milliamperes are as follows:

1. LEAD PLACEMENT - place the leads in the proper input jacks. Usually the leads are connected to the + and - jacks, as before for milliamps. Other jacks for amps or for microamps are available when reading these respective values of current.

2. POLARITY SWITCH - this switch is to be on DC+, as the VOM's don't usually measure AC current.

3. FUNCTION-RANGE SWITCH - turn this switch to the highest range. This stip should be done when measuring any current, unless you are definitely sure that the current will be less than maximum for a lower range.

4. METER CONNECTION - to be measured, all of the current that flows through the component must also go through the meter. To make this possible, it is necessary to open the circuit and insert the meter in series. Assume we have the circuit of Figure 1, and we wish to measure the current at point B.

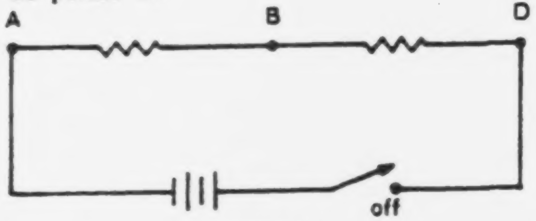


FIGURE 1

Step a - TURN OFF THE POWER.

Step b - Break the circuit at point B as shown in Figure 2.

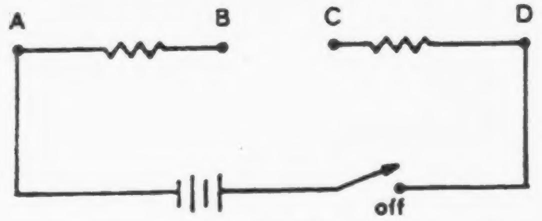


FIGURE 2

Step c - Connect the meter as shown in Figure 3 with the negative lead toward the negative side of the circuit (point B, in this case) and the positive lead to the positive side of the circuit (shown as point C). Have the instructor check the connection to be sure you are right.

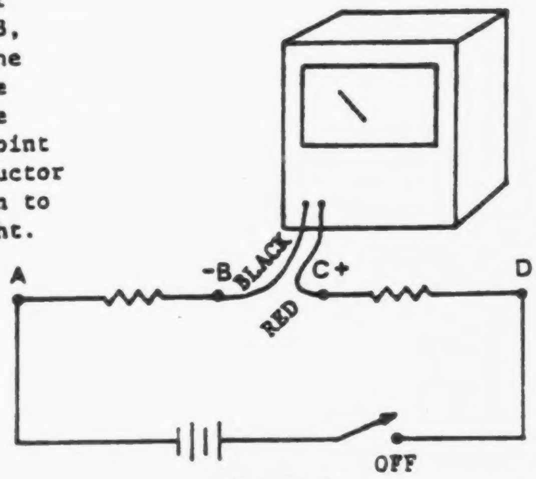


FIGURE 3

5. CIRCUIT ON - with the circuit turned on, measure the current flowing through the circuit. If the needle does not go above ¼ of the scale, turn the range switch down one range at a time until the needle moves into the middle or upper half of the scale. (Figure 4). At this time, take you reading.

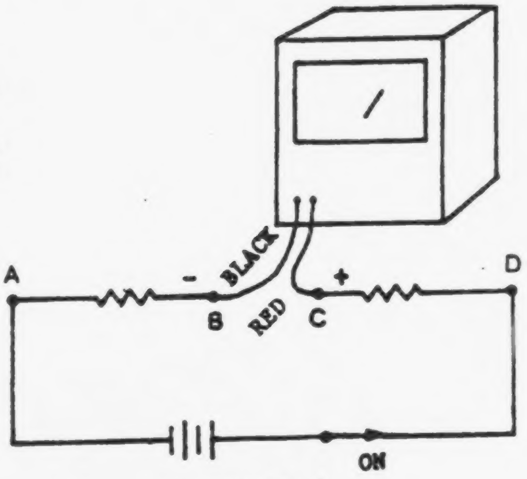


FIGURE 4

6. CIRCUIT OFF - turn off the circuit, remove the meter, and turn the meter of "OFF" or highest voltage range to protect the VOM. Switching to the highest voltage range switches out the ohmmeter and the ammeter sections of the VOM. Both the ohmmeter and ammeter sections can be easily damaged by external voltages. Only switch in the ohmmeter or ammeter sections when you need them, otherwise switch to "OFF" or to a high voltage range for protection of the meter.

The current meter should never be placed in parallel with any component in the circuit because the meter has a very low internal resistance. It will act like a short circuit; and with high current flowing through the meter itself, the meter movement will become damaged because it can handle only a very small amount of current.

INFORMATION SHEET 4

MEASURING RESISTANCE WITH THE VOM

When measuring resistance with the VOM, it is necessary to follow certain general procedures. These are as follows:

1. LEAD PLACEMENT - Place the leads into the proper input jacks. These will be the + and - jacks, as used for most other measurements.

2. POLARITY SWITCH - This switch is placed in the DC+ position, as the meter will not work properly when on AC or DC-.

3. METER ZERO - The meter must be set on zero on both sides of the scale to measure resistance. Nearly all VOM's have the highest resistance where the smallest current flows. The highest resistance readings are, therefore, on the left of the scale and the VOM usually does not have an adjustment for this side. The meter zero allows the operator to set the meter so most current is flowing when the resistance is zero. This adjustment is made as follows:

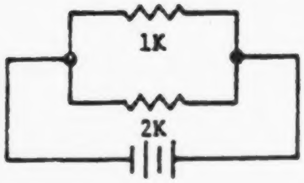
   Step a - With the range switch on the resistance range desired, touch the two leads together (short circuit).

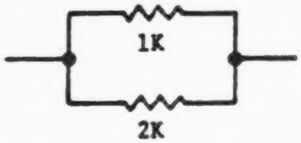
   Step b - Move the zero adjustment so the needle points over the extreme right hand side to zero on the ohms scale.

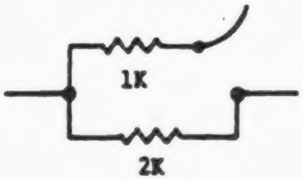
   Step c - Disconnect the leads. Do not leave the leads shorted together, as this will run down the batteries in the meter!

4. FUNCTION-RANGE SWITCH - This switch may be placed on any range desired for resistance measurements. The range switch selects the multiplier for the meter. To find the actual resistance of the circuit, take the reading from the meter scale and multiply it by the number on the range. For example, if the reading on the VOM is 2.2 and the range is R x 100, the value would be 2.2 times 100, or 220. (Because of the limited number of ranges, the VOM is less desirable for measuring resistances than a VTVM.)

5. DISCONNECT RESISTOR - The resistor under test must be disconnected from any source of power to avoid damage and to give an accurate reading. Assume the circuit shown below. If you wanted to measure the 1K resistor, it would be necessary not only to disconnect the resistor from the power but from the other resistor so only the 1K resistor would be measured.







6. Read the meter scale and multiply times the range setting, and record the value if necessary. (If a range setting adjustment is necessary for a good reading, be sure and check zero ohms again at the new range setting.)

7. When finished with the readings, turn the meter to the "OFF" position or to the highest voltage range to protect the meter.

INFORMATION SUMMARY

After completing this package you should be able to quickly and accurately read nearly any meter scale that you encounter in your work. This will be a very valuable skill.

When reading a meter you must first look at the range switch position to know which scale to look at. Sight the pointer and scale perpendicular to the meter face. Then the indicated value under the pointer can be read.

Remember that the smallest percent of error is obtained with full scale deflection of the meter. But when reading non-linear scales there will be a greater percentage of error because of the bunching and spreading of the scale. For best overall acuracy, you should read the meter on a scale which allows the pointer to indicate at mid-scale whenever possible.

$$\text{Percent accuracy} = \frac{\text{Full scale accuracy x full scale value}}{\text{indicated value}}$$

Actual error = Full scale accuracy x full scale value

INFORMATION

Part 1

Meters are used to measure voltage, amperes (current), and resistance. An indicating arm called a "needle" or "pointer" operating in a manner similar to a motor moves to a position over the markings on the meter face indicating the amount of current flowing through the meter.

The markings on a meter face are similar to the markings on the face of a clock.

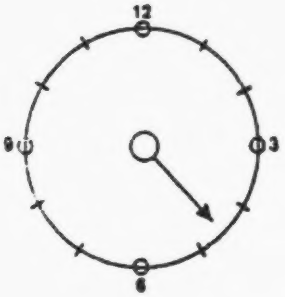


Fig. 1-A

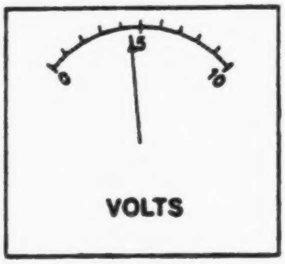


Fig. 1-B

If the minute hand is removed from the clock we would estimate the time as being 4:30 because the hour is halfway between 4 and 5. We could also indicate this time as being 4.5 hours past twelve. In Figure 1-B the meter needle is pointing halfway between the five and next lower mark on the face of the meter. By counting the equally spaced marks we can assume that the reading would be 4.5 volts. It would be "volts" because the name on the meter indicates this.

Using this reasoning, determine the voltages indicated if the meter needle pointed to the following points:

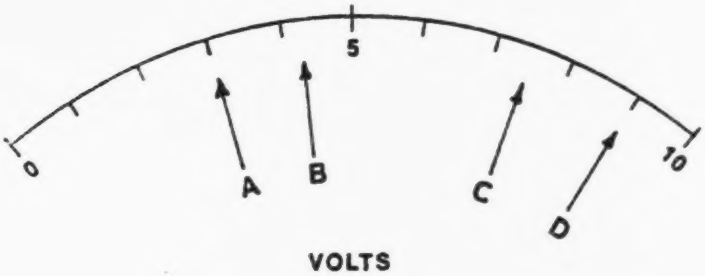


Fig.2

In Figure 2, we find that pointer A is two equally spaced marks to the left of the 5 volt mark. Counting from the 5 volt mark, we see that these two marks represent the pointer positions for 4 volts and 3 volts respectively. Pointer B, however, is between the 4 and 5 volt marks. By estimating we can see that it is about ¼ of a division greater than 4 volts. This voltage can be interpolated as 4.25 volts. Pointer C is half a division above 7 volts or at 7.5 volts. Pointer D is at the ninth division and indicates 9 volts.

Interpolating is the accurate estimation of values between the scale division markers.

Part 2

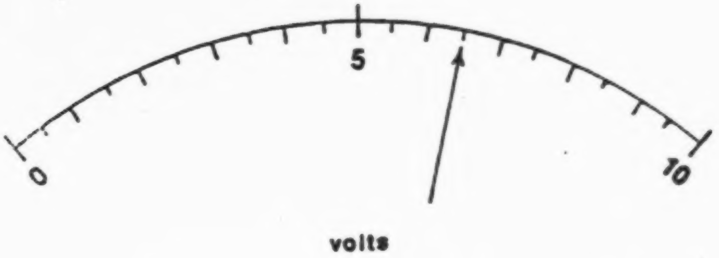


Fig. 3

On the meter face in Figure 3, we see small marks between the larger marks. The small marks now indicate the half-volt graduations so we no longer have to guess where they are. The needle would now indicate 6.5 volts.

VOM's or multi-function meters have a "range switch" that extends the operating range of the meter. Without it this meter only has a 0-10V range. A range switch might look like Figure 4.

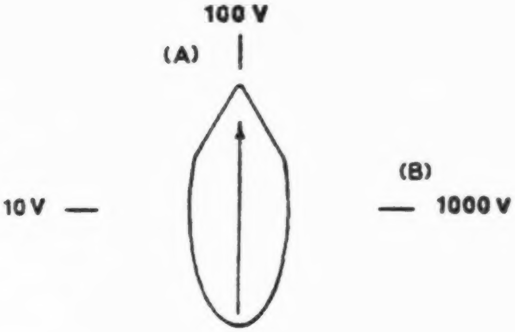


Fig.4

We now have two new ranges, A and B. With the range switch at A (100V) the meter has a full-scale reading of 100 volts so we multiply all of our readings by 10 times - the pointer would now be indicating 65 volts. If we switched to the 1000V range a similar reading would indicate 650 volts. The range switch indicates the full scale range of the meter.

Current or ampere ranges follow this same rule. Other types of scales may also be printed on the face of the meter such as the resistance or ohms (Ω) scale. Voltage or current meters draw the power to operate themselves from the circuit they are connected to. However, the ohmmeter has an internal battery to provide current for operation.

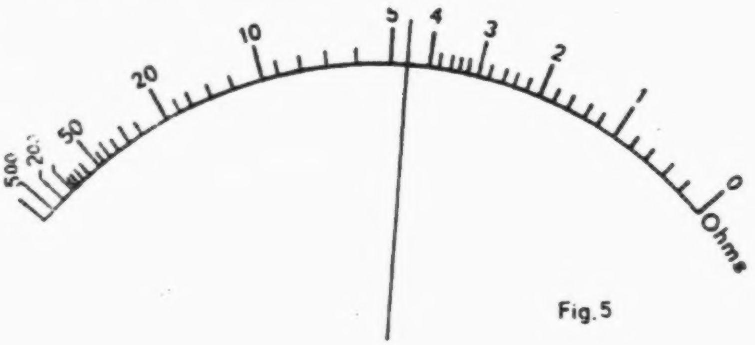


Fig.5

A typical ohmmeter scale would look like Figure 5. You will notice that the distance between 1 and 2 is not the same as the distance between 4 and 5. Because of this we say that scale is "non-linear". The scale in Figure 3 in "linear" because there is equal spacing between numbers. In Figure 5 the ohmmeter needle is indicating 4.5 ohms of resistance.

An ohms range switch might look like Figure 6.

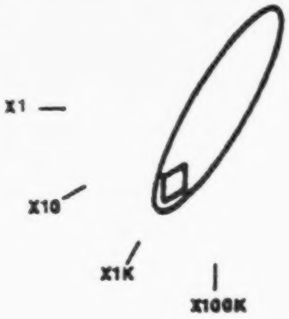


Fig.6

These positions mean that any reading made on the scale should be multiplied by the number of times indicated by the range switch.

Our former reading of 4.5 ohms would have been 4,500 ohms if the switch had been placed as shown above.

Part 3

Accuracy: The accuracy of a meter is specified as a percent of full scale reading. If a meter has a full scale accuracy of 3 percent, it will have 6 percent accuracy at ½ scale, 9 percent accuracy at 1/3 scale and 12 percent accuracy at ¼ scale deflection. However, for overall accuracy, readings should be made near the half-scale deflection area for best accuracy. Tapping gently on the meter face when the reading is taken will often help overcome friction in the meter bearings and allow the needle to come to rest at the proper reading.

Accuracy of any reading on the scale can be calculated by use of this equation:

$$\text{Percent accuracy} = \frac{\text{full scale deflection x full scale accuracy}}{\text{actual deflection}}$$

The accuracy of non-linear scales such as ohmmeter scales can be calculated by using the point on a linear scale under the needle position for reading ohms.

Examples: 1. In Figure 2, if the full scale accuracy is ±3% then the accuracy of reading B is $= \frac{10 \times 3}{4.0} = 7.5\%$

2. Reading C has an accuracy $= \frac{10 \times 3}{7.5} = 4.0\%$.

3. Calculate the accuracy of readings A and D in Figure 2

Solutions for A and D:

A. $\% \text{ accuracy} = \frac{10 \times 3}{3} = 10\%$

D. $\% \text{ accuracy} = \frac{10 \times 3}{9} = \frac{30}{9} = 3.3\%$

Actual error: The actual error is the number of volts, amperes, ohms, etc. that your reading could be off. For example, if your reading is 6 volts and the accuracy is ±8% , then the actual error is ±.48 volts. This can be easily calculated by this formula:

Actual error = % accuracy x indicated value

Example: Indicated value for reading C in Figure 2 is 7.5 volts and the accuracy is ±4.0%.

Actual error = .04 x 7.5 = .3 volts

Try calculating the actual error for readings A and D of Figure 2.

Note that in all cases, the actual error for a given reading is the meter accuracy multipled by the full scale deflection value, .03 x 10V = .3V. Therefore another and simple formula is:

Actual error = % full scale accuracy x full scale value

Answer to the last example:

A. Actual error = 0.10 (from accuracy calculations) x 3v = ±0.3v

D. Actual error = 0.33 x 9v = ±0.3v

Part 4

A word about accuracy

Many people try to read a meter to an accuracy greater than can be justified. For example, when estimating a needle position between two scale markers (called interpolating), there is a tendency to try to read to a tenth of a scale division. In Figure 2 we might estimate this to be 4.25 volts.

1. When writing a measurement you may sometimes consider only the last figure in the number to be estimated. In the 4.25 number, the 2 and the 5 are both estimates. Thus writing this as 4.2 or 4.3 would be better if this is the accuracy desired.

2. You gain accuracy by reading the meter as close as possible to the indicated value. Remember - - sight the pointer and scale perpendicular to the meter face to prevent parallax, then interpolate for the most accurate reading.

3. Most meters are very accurate devices. The components range from 1% accuracy to precision values in the important circuits. A meter that has 2% - 3% accuracy for full scale deflection (f.s.d.) should be read at least as accurately by you.

EXPERIMENT

EXPERIMENT 1

VOLTAGE MEASUREMENT WITH THE VOM

Before doing this experiment, be sure you have read the Information Sheets 1 and 2 and have read the section of the VOM Operation Manual that deals with voltage measurement.

MATERIALS REQUIRED:

Power source - 3 assorted dry cells and batteries
Low voltage DC power source
Low voltage AC power source
(Filament supply on H.V.P.S.)
Meters - VOM
Resistors - 2.2K, and 3.3K

PROCEDURE:

1. With the VOM, following the procedure outlined in the Information Sheet 2, measure the voltage of the three cells or batteries and record their values in the table below.

Cell or Battery	Unit 1	Unit 2	Unit 3
Range used			
Voltage			

2. Set your meter for measuring AC volts and measure the voltage of the low voltage AC source. Record below.

   AC voltage = ____________________

3. Set your meter for measuring DC and set the low voltage DC power supply for 15 volts using your VOM. Have the reading checked by your instructor.

4. Connect the circuit in Figure 1.

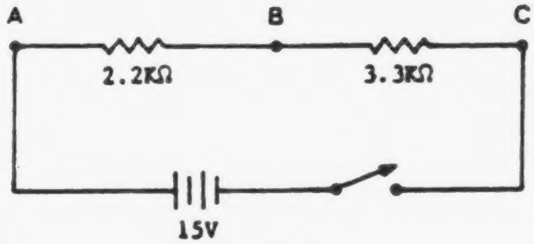


FIGURE 1

5. With the VOM measure and record the voltages in the circuit between points A to C, A to B, and B to C. Indicate the range used for each measurement.

Measuring location	A to C	A to B	B to C
Range used			
Volts			

6. To check your results, have your instructor, or another student who has completed this package, help you.

Lab # ________________

Name ____________________

Date __________ Per ______

EXPERIMENT: Measuring Voltage

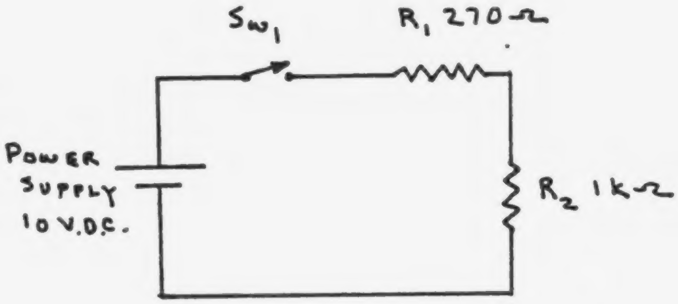
Objective: To be able to use the VOM to measure voltage

To be able to use the DMM to measure voltage

To be able to use the FET Meter to measure voltage

Proceedure

Set up this curcuit



Measure the following

		VOM	DMM	FET
a. With Sw_1 Open	E_{P_S} -	______	______	______
	E_{R_1} -	______	______	______
	E_{R_2} -	______	______	______
	E_{sw_1} -	______	______	______
b. With Sw_1 Closed	E_{P_S} -	______	______	______
	E_{R_1} -	______	______	______
	E_{R_2} -	______	______	______
	E_{sw_1} -	______	______	______

Conclusions

1. Write conclusions about the voltages measured.
2. Write conclusions about the meters used.

EXPERIMENT II

CURRENT MEASUREMENT WITH THE VOM

Before doing this experiment, be sure you have read Information Sheet 3 and have read the section of the Operator's Manual for measuring DC milliamperes.

MATERIALS REQUIRED:

Power source - Low voltage DC power supply
Meter - VOM
Resistors - 2.2K and 4.7K

PROCEDURE:

1. With the VOM, following the procedure outlined in Information Sheet 3, set up the circuit of Figure 2 for measuring current at point B as shown. Have your circuit checked before continuing.

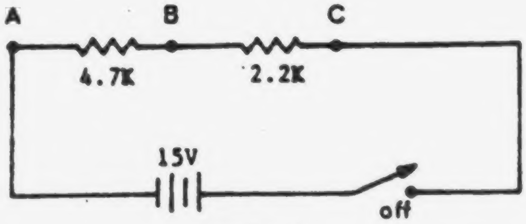


FIGURE 2

2. Record in the table provided, the current at each of the points indicated in Figure 3.

Measuring location	B	C
Range		
Current (ma)		

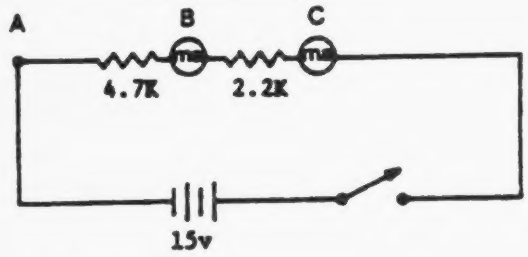

A
B
C
ma
ma
4.7K
2.2K
15v

FIGURE 3

EXPERIMENT III

RESISTANCE MEASUREMENT WITH THE VOM

Before doing this experiment, be sure you have read Information Sheet 4 and have read the section of the VOM Operation Manual that deals with resistance measurement.

MATERIALS REQUIRED:

Power source - None
Meters - VOM
Resistors - Ten assorted resistors

PROCEDURE:

1. With the VOM, and following the procedure outlined in Information Sheet 4, measure the resistance of each of the resistors given to you. Be sure to write down the color coded value of the resistors and the tolerances.

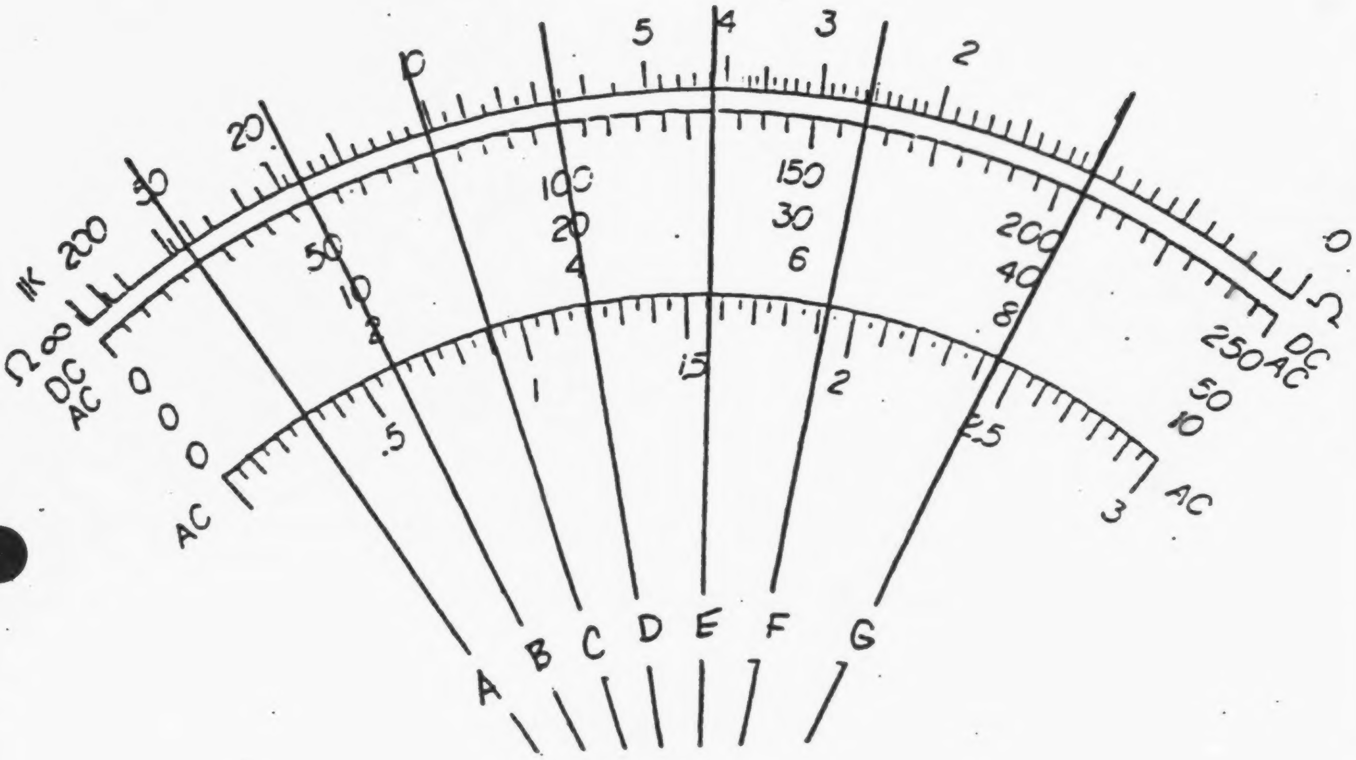
Coded Value	Tolerance	Measured

WORKSHEET

Meter Scales (Voltage)

NAME ______________________________

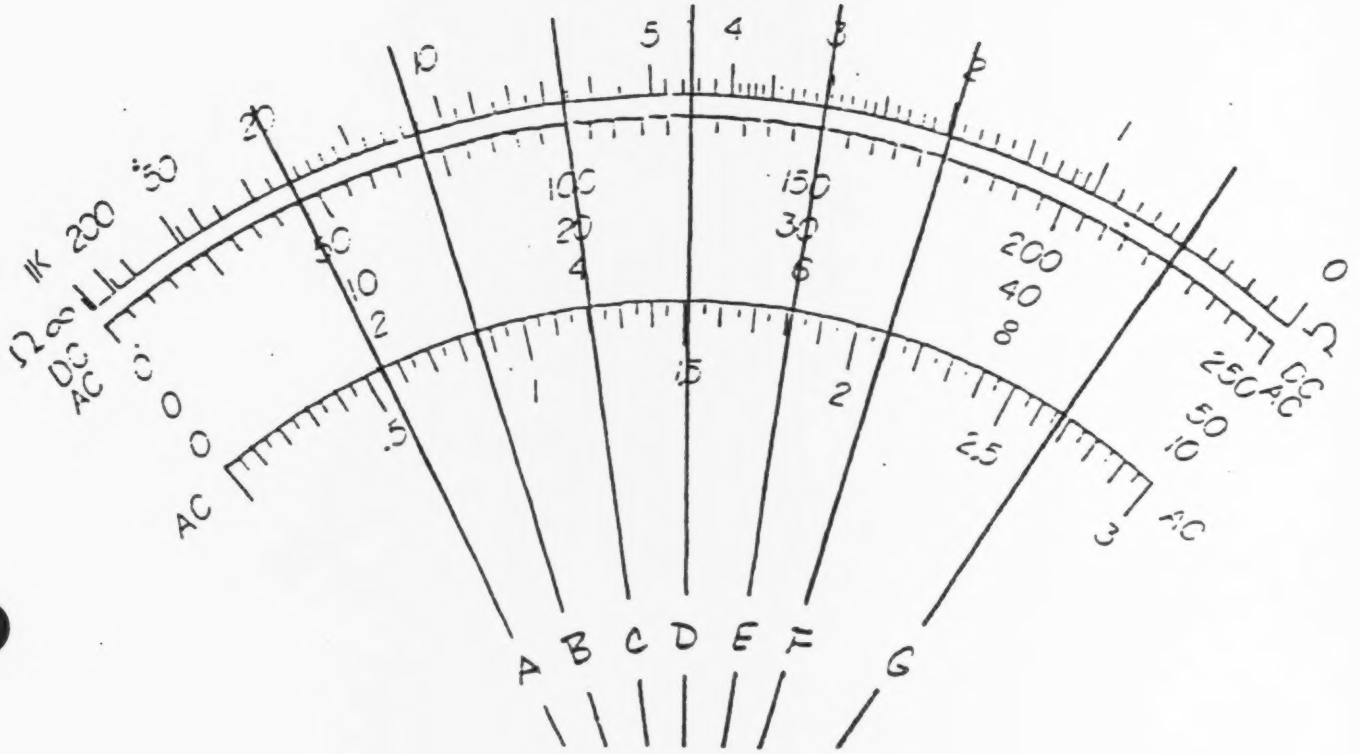
Voltage D.C.



Ω ∞
1K 200
50
20
10
5
4
3
2
0
Ω
DC
AC
0
0
0
50
10
2
100
20
4
150
30
6
200
40
8
250
50
10
DC
AC
.5
1
1.5
2
2.5
3
AC
AC
A
B
C
D
E
F
G

	RANGE	READING	RANGE	READING
A	250		50	
B	10		2.5	
C	50		1000	
D	2.5		250	
E	10		50	
F	50		10	
G	2.5		50	

CURRENT IN MA DC

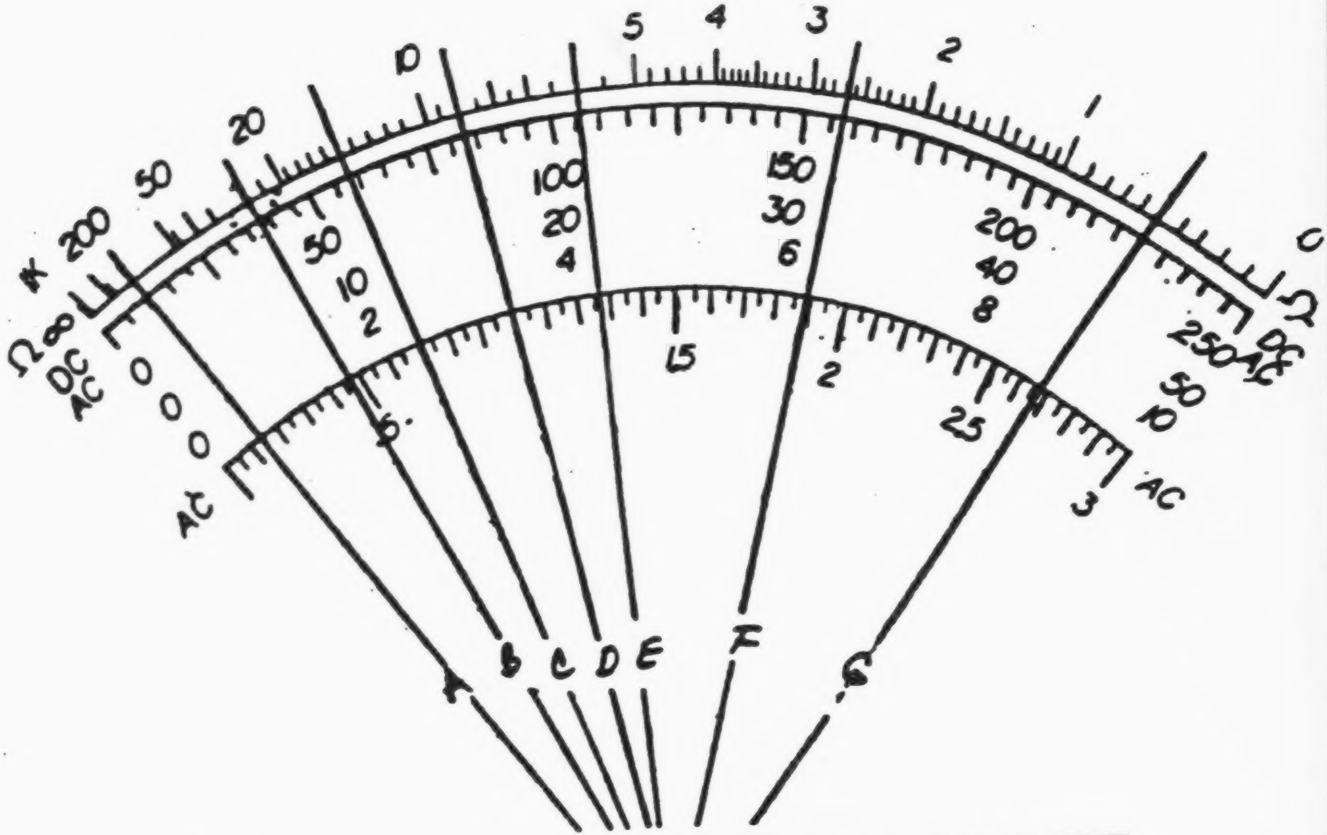

1K
200
50
20
10
5
4
3
2
1
0
Ω ∞
Ω
DC
AC
0
0
0
50
100
150
200
250
10
20
30
40
50
2
4
6
8
10
.5
1
1.5
2
2.5
3
AC
AC
A
B
C
D
E
F
G

	RANGE	READING	RANGE	READING
A	250		50	
B	10		2.5	
C	50		1000	
D	2.5		250	
E	10		50	
F	50		10	
G	2.5		50	

COLOR CODE

COLOR CODE	COLOR CODE VALUE	RESISTANCE IN K OR MEG	TOLERANCE
RED RED BLACK GOLD			
BRN BLK RED SILVER			
BRN GRN. BRN SILVER			
OR OR GOLD SILVER			
OR WHT BRN SILVER			
GRN BLUE BRN SILVER			
BRN GRAY RED SILVER			
OR. WHT RED SILVER			
BLUE GRAY RED GOLD			
BRN GREEN ORANGE GOLD			
GRAY RED ORANGE GOLD			
YELLOW VIOLET YELLOW GOLD			
BRN. BLK YELLOW Gold			
BLUE GRAY YELLOW Gold			
BRN GRN RED			
RED VIOLET BROWN			
OR OR BRN			
GRN BLUE RED			
GRN BLUE ORANGE			
BRN BLACK GRN. SLVR.			
BRN RED GRN. SLVR			
RED RED GRN GOLD			
OR. OR SILVER SILVER			

RESISTANCE


Ω ∞
1K
200
50
20
10
5
4
3
2
1
0
Ω
DC
AC
0
0
0
50
10
2
100
20
4
150
30
6
200
40
8
250
50
10
DC
AC
.5
1.5
2
2.5
3
AC
A
B
C
D
E
F
G

	RANGE	READING	RANGE	READING
A	X1		X10	
B	X100K		X1K	
C	X1		X1K	
D	X10		X100K	
E	X100K		X1K	
F	X1		X100K	
G	X10		X1K	

5

Lab # ________

Pg. 1

Name ____________________

Date ________ Per________

Experiment-Series Circuit

Objective:

To be able to use the related equipment.
To be able to understand voltage and current in a series circuit.
To be able to measure current in a circuit

Review

Voltmeter - List three rules for use of voltmeter

1. ______________________________

2. ______________________________

3. ______________________________

Ammeter - List three rules for use of the ammeter

1. ______________________________

2. ______________________________

3. ______________________________

Proceedure

1. Set up each circuit and measure voltage and current.

2. Record your results on pg 2. Results listed under data

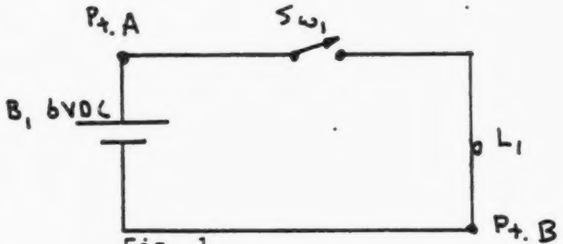

Pt. A
Sw1
B1 6VDC
L1
Pt. B

Fig. 1

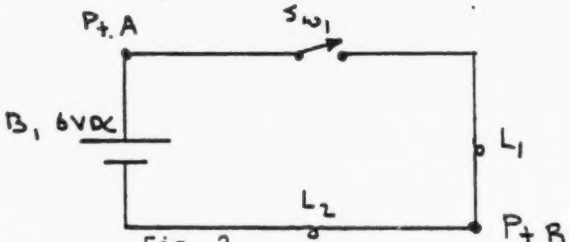

Pt. A
Sw1
B1 6VDC
L1
L2
Pt B

Fig. 2

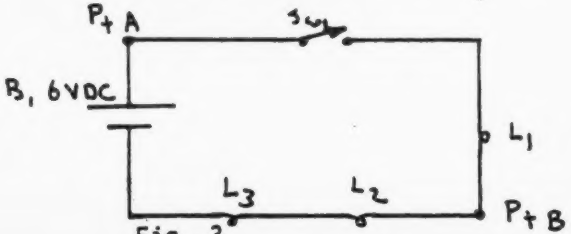

Pt A
Sw1
B1 6VDC
L1
L3
L2
Pt B

Fig. 3

Data for Fig. 1

Voltage	Vom	DMM	Current	VOM	DMM
E_+ =			I_{P+A} =		
E_{L_1} =			I_{P+B} =		

Data for Fig. 2

E_+			I_{P+A}		
E_{L_1}			I_{P+B}		
E_{L_2}					

Data for Fig. 3

E_+			I_{P+A}		
E_{L_1}			I_{P+B}		
E_{L_2}					
E_{L_3}					

Conclusions/Questions

1. What is the power supply output? ____________________
2. What is protecting the power supply from short circuit?

   ____
3. Blk. indicates ______________ Red indicates ____________
4. How many paths for current are there in each circuit? _____________

   What do we call a circuit with one path for current? _____________
5. What happens to voltage across each lamp as we add lamps in series?

   ____
6. What happens to current as we add lamps in series? __________________

5

7. Draw a series circuit with a battery, a lamp, a switch, and the ampmeter in series.

8. Draw a circuit with a battery, switch, two lights.
Draw the amp meter connected to measure current.
Draw the voltmeter to measure voltage across two components.

9. List three requirements of any circuit.

1. ________________ 2. ________________ 3. ________________

10. If you remove one lamp in fig. 3 what will happen to the other lamps? ____________________ try it? ________________
Why? ______________________

Lab Exp. # ____________ Name ____________________

Experiment - Parallel Circuit Date __________ Per. ______

Objective: To understand voltage and current in a parallel circuit.

To measure voltage in parallel circuits.

To measure current in a parallel circuit.

To use related test equipment

Review

1. Draw a series circuit with to lamps

2. Draw a series circuit. Show how to connect the ammeter & voltmeter.

2. Tell me what you know about current & voltage in a series circuit.

a. - voltage - ____________________________________

____

b. - current - ____________________________________

____

Proceedure

1. Set up the circuit and measure voltage and current

2. Record your results

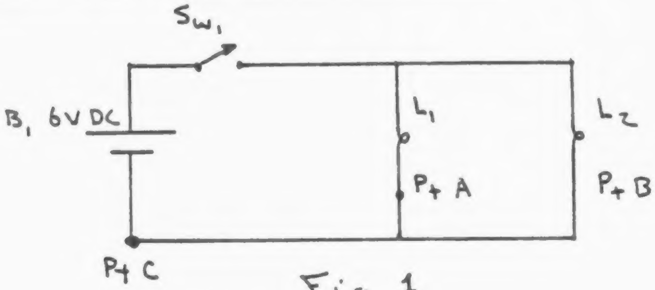

Sw1
B1 6V DC
L1
L2
Pt A
Pt B
Pt C

Fig 1

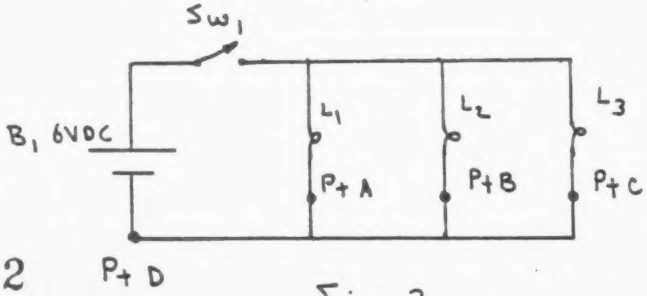

Sw1
B1 6VDC
L1
L2
L3
Pt A
Pt B
Pt C
Pt D

Fig 2

Data for fig. 1

Voltage	VOM	DMM	Current	VOM	DMM
E_+	______	______	I_{P+A}	______	______
E_{L_1}	______	______	I_{P+B}	______	______
E_{L_2}	______	______	I_{P+C}	______	______

Data for fig 2

E_+	______	______	I_{P+A}	______	______
E_{L_1}	______	______	I_{P+B}	______	______
E_{L_2}	______	______	I_{P+C}	______	______
E_{L_3}	______	______	I_{P+D}	______	______

Conclusions

1. Remove one amp in fig. 2 circuit? ______ What happens? ____________ ______________ Is this the same as in the experiment on series circuits? ______________ Why? ______________________________ ____

2. Write a conclusion about voltage in:

   A. Series Circuit

   ____
   ____
   ____
   ____

   B. Parallel Circuit

   ____
   ____
   ____
   ____

3. Write a conclusion about current in:

   A. Series Circuit

   ____
   ____
   ____
   ____
   ____
   ____

   B. Parallel circuit

   ____
   ____
   ____
   ____
   ____
   ____

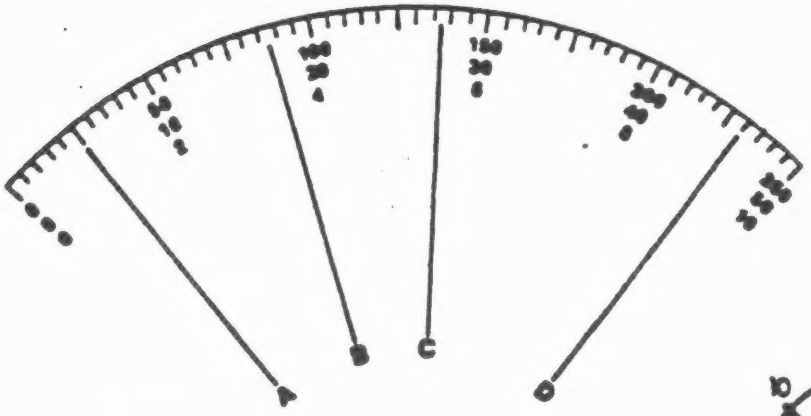
NAME ____________________________

Test A

Directions Do the following problems. (Do not write answers on test) Place all answers on answer sheet.

1. For figure 1, give the value indicated for pointer positions A,B,C,D.

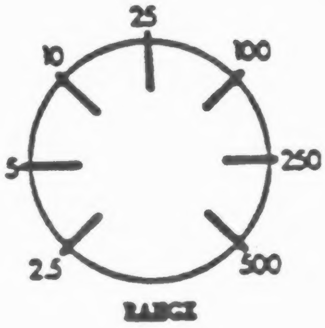
#1 A________ #2 B________ #3 C________ #4 D________



100
20
4
150
30
6
A
B
C
D

RANGE SWITCH POSITIONS:

Needle position A-	10
Needle position B-	2.5
Needle position C-	500
Needle position D-	25

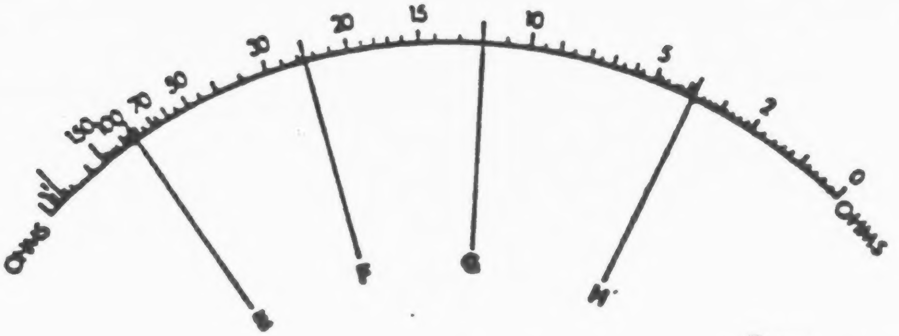


25
10
100
5
250
2.5
500
RANGE

FIGURE 1

2. For figure 2, give the value indicated for pointer positions E,F,G,H.

#5 E________ #6 F________ #7 G________ #8 H________


OHMS
150
100
70
50
30
20
15
10
5
2
0
OHMS
E
F
G
H

	Range Switch Settings
Needle position E-	R x 1
Needle position F-	R x 10,000
Needle position G-	R x 100
Needle position H-	R x 100,000

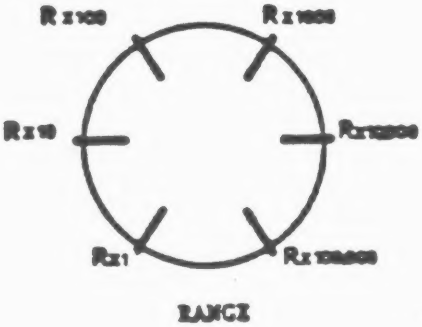
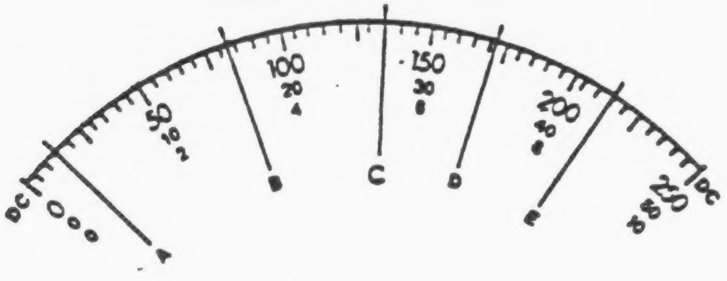

R x 100
R x 1000
R x 10
R x 10000
R x 1
R x 100000
RANGE

FIGURE 2

Name ____________________

Test B

Directions Do the following problems.



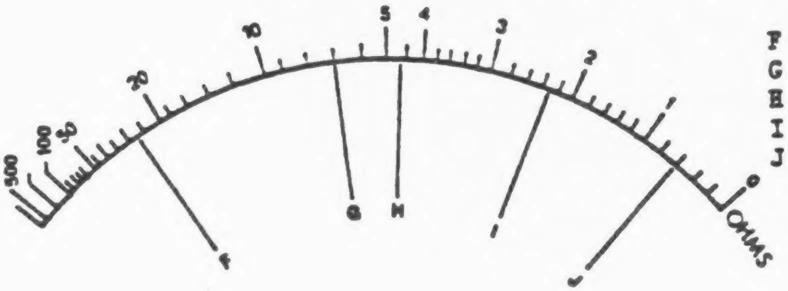
DC
0
50
10
2
100
20
4
150
30
6
200
40
8
250
50
10
DC
A
B
C
D
E

Ranges
A - 1V
B - 2.5V
C - 500V
D - 50V
E - 100V

1. Read each indicated value for A,B,C,D,E.

#9 A__________ #10 B__________ #11 C__________ #12 D__________ #13 E__________

....



500
100
50
20
10
5
4
3
2
1
0
OHMS
F
G
H
I
J

Ranges
F - R x 10
G - R x 10
H - R x 1K
I - R x 10K
J - R x 100K

2. Read each indicated value for F,G,H,I,J.

#14 F__________ #15 G__________ #16 H__________ #17 I__________ #5 J__________

....

DIRECTIONS:

The following questions refer to the Lab. Stations at the back of the room.

You will have 5 minutes at the Lab. Station.

As soon as a Lab. Station is free you may move to a Lab. Station. Be sure you record the Lab. Station number on your answer sheet.

Answer the following questions

#19. What is the color code value of R_1? ____________

#20. What is the color code value of R_2? ____________

#21. What is the measured value of R_1? ______________

#22. What is the measured value of R_2? ______________

SET THE POWER SUPPLY FOR 1) V.D.C.

#23. Measure E_{R_1}

#24. Measure E_{R_2}

#25. Measure I in the circuit.

READING METER
(SỰ ĐỌC MÁY ĐO).

Individualized learning systems:
Hệ Thống học - cá nhân

Involve	gồm, chỉ
Measure	đo
Measuring	sự đo, việc đo máy
Voltage	VOLT, Điện Thế
Current	Cường độ dòng điện
Resistance	Điện trở, cản điện.
Measurement	sự đo máy
a meter scale	một mặt cân của máy đo.
Voltmeter	Máy đo điện thế (đo VOLT).
Scale	Cân trên máy đo.
pointer	Kim của Cân trên máy.
accuratly	chính xác
accuracy	sự chính xác
actual	có thực, hiện tại

error	sự sai lầm trên máy (như đọc, nhìn kim..)
Interpolation	sự thêm thắt, thay đổi (chỉ sự thay đổi Range switch khi thực hiện 1 phép đo rồi hạ Range cho đúng chỉ số để đọc trên scale)
Needle = pointer	Kim máy đo trên scale.
linear	mặt cân chia đều
Non-linear	mặt cân chia không đều như Ohmeter.
Nearly	gần như
encounter	gặp nhau (chỉ sự các loại máy đo)
skill	tài khéo
perpendicular	thẳng góc, trục thẳng góc (⊥)
face	mặt
Indicate	chỉ rõ.

Obtain	Nhận được.
full scale deflection	Sự chênh lệch trên cân (đày)
Greater percentage	phần trăm lớn hơn.
Bunching	chùm, nhóm, tốp
spreading	Trải dài
Overall	gồm mọi (vật)
Allow	cho phép.
Indicate	chỉ
Mid. scale	Nửa cân, giữa cân.
Manner	kiểu
position	vị trí
mark	dấu
Marking	làm dấu
Through (To Threw)	xuyên qua (mém qua).
Estimate	xét đoán
Halfway	nửa chặng, nửa đường
By counting	Bằng cách đếm
Assume that	cho rằng, giả định là

Reasoning	sự lý luận.
Determine	xác định.
Represent	thay mặt.
Respectively	theo Thứ tự.
However	Tuy nhiên.
By estimating	bằng sự xét đoán
Interpolate	Thêm rào
Graduation	sự chia bậc
half-Volt	nửa VOLT
guess	ước đoán.
extend	phóng ra.
multi	phần tăng bội.
VOM	VOLT-OHM-MILLIAMMETER máy đo VOLT-OHM-mA
Ohmmeter	máy đo điện trở.
Solution	nghiệm số
justified	
prevent	ngăn cản
parallax	sự đọc nhầm lẫn trên cân.
precision	sự đúng chính xác
Component	bộ phận cấu tạo (như Resistor, diode ...)

Deflect	làm lệch đi
Triplett 630	máy Triplett 630
Simpson 260	máy đo ohm hiệu Sampson 260.
Voltage supply	điện thế cung cấp
Adjust	điều hoà
Repeat	lặp lại
until	cho đến khi
feel	cảm thấy
to be able to	có thể
power source	Cung cấp (điện)
Schematic diagram	biểu đồ vẽ bằng ký hiệu điện.
Disconnect ≠ Connect	Tách ≠ nối
Immediately	ngay lập tức
Adjust control	nút điều hoà trên máy đo
Discharge	phóng thích
External	bên ngoài
agree	đồng ý
value agree	giá trị được chấp nhận

ĐO OHM ?

Khi muốn đo điện trở, trước nhất điện trở phải tách ra khỏi nguồn có điện thế cung cấp. Kế đến xác định số lường giá trị của điện trở rồi chọn Range switch cho tương xứng. **Nhớ**: khi đổi range lên cao hay xuống thấp phải luôn nhớ điều hoà "kim" về zero bên tay phải của "scale". Sau đó xử dụng test lead và đo điện trở ta sẽ đạt trị số ohm khá chính xác.

儀錶（电錶）METERS

資料摘要 INFORMATION SUMMARY

VOM是一种多功能的儀器。某製造商宣稱有1001种，它像許多其他儀器一樣不需要外來的电源而適合在室外現場或工作间裏使用。

VOM用以测量电流，电压及电阻。

测量电流時，电錶必须与被测点的电路接成串联。即錶的正極接电路的正極，錶的負極接电路的負極（觀测極性）。电錶要定在最高电流範圍以保護电錶。你絕不能將电錶与电路並联連结。一定要串联以使全部电流流经电流錶。

测量电压時，电錶必须与被测点的电路接成並联。錶要定在最高电压範圍以保護电錶。錶的正極与电路正極相接，錶的負極与电路負極相接。

测量电阻時，先要將电路的每個电源均切断，以保護电錶。被测电阻器一端电路必须切断而只测該电阻器的电阻。

VOM被設計测量直流电流（DC current），交流及直流电压（AC and DC Voltage）及电阻（Resistance）。若正確地使用。VOM是工作間內最有效的电錶，你必須記住，若电錶使用不當，則會像其他精密儀器一樣失去效率。

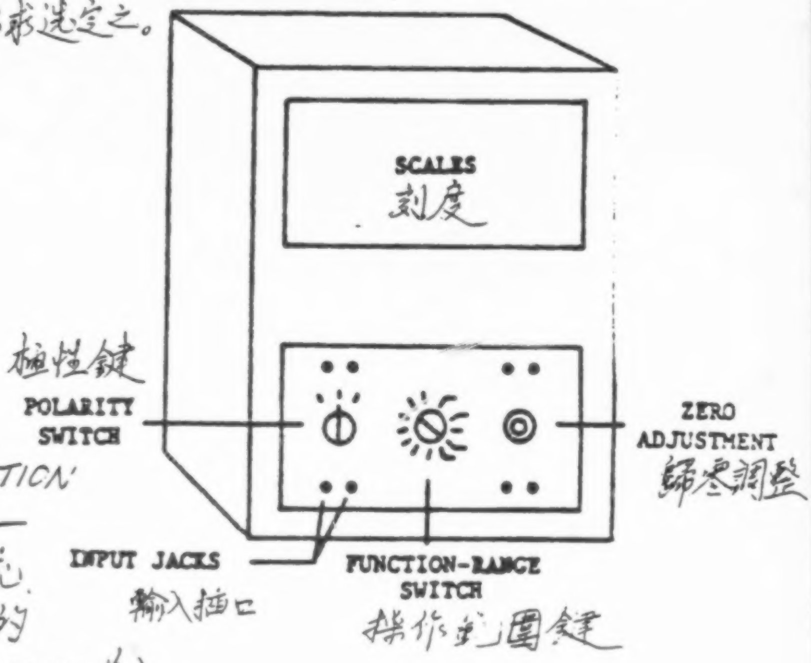
資料一：INFORMATION SHEET 1

伏特一歐姆一千分之一安培(VOLT-OHM-MILLIAMMETER)电錶通論。

商用型伏特一歐姆一千分之一安培电錶(Volt-Ohm-Milliammeter; VOM)能測交流及直流电压,直流电流及电阻。有時其他功能也会被設計進

大多數VOM有許多共同特点：

1. 極性鍵(POLARITY SWITCH)—用以选擇 +DC, -DC 或 AC. 依你欲測量類型需求选定之。(如圖例)


SCALES
刻度
極性鍵
POLARITY SWITCH
ZERO ADJUSTMENT
歸零調整
INPUT JACKS
輸入插口
FUNCTION-RANGE SWITCH
操作範圍鍵

2. 操作範圍鍵(FUNCTION-RANGE SWITCH)— 选擇使用類別(电流、电压或电阻)及測量的範圍(如 100 ma 或 10 ma 等) 每次只能选一种範圍來使用.

3. 歸零調整(ZERO ADJUSTMENT)——(有時称為零歐姆 zero ohm 在电阻計(錶)(ohmmeter)內电路上的一個可变电阻器,用以測电阻時調整儀錶內电池的电压。选任何一电阻範圍 調整。当电阻錶的兩支引线(leads)相接觸,使錶上指針指 (通常在錶右側)。此時因無电阻在此兩支引线之间,則电阻錶必須指零。每选一次範圍均需歸零調整。

EL-IC-04

4. 輸入插口（INPUT-JACKS）——測量引线插入电錶的孔. 孔邊有標明"+"及"-"(或 common).若有疑问則查阅操作手册.

5. 电錶刻度（METER SCALES）——有如半圓規的边被分隔成
多小刻度用以讀出數值。

6. 測量引线（TEST LEADS）——接連儀錶与被测组件的电线
紅色引线代表正極"+"，黑色引线代表負極"-"(共同 commo
極). 接連引线時要注意其極性，在直流电路应用上，錯接
性会使指針旋轉軸扭弯或倒轉而損坏电錶。在交流电
上極性則不重要。

所有 VCM 均為十分靈敏的电錶，測不同的电压及电流時要
变換其測量範圍及操作种類。

只需測量之电流達五千萬分之一安培（0.00005 A 或 50 micro A）
可使 VOM 的指針旋轉。所以若电錶使用不当会很快地受損。
所有的儀錶均是設定在正確使用的條件下設計的. ~~每具~~ VOM 电
儀價值 $100.-（若是由於你錯誤使用則你要負責）。VCM 电錶
使电路电流有些微下降，即可以說是 VCM 电錶电路的电負荷
在某些电路上此电負荷是很顯著的. 這也是測量時發生誤差的
原因之一。在高电阻电路上或电錶选在低範圍時，此种电負荷
最明顯。

資料二: INFORMATION SHEET 2

下面解說用VCM电錶測电压的一般程序,其適用於大多數电錶
只有少數例外。

1. 為使电錶儘量精確。其电錶尚未接电路將其指針須在刻度
左側零点處。若否,請知道如何歸零調整的人來調整。

2. 引线插孔(LEAD PLACEMENT)——將引线插入正確的插孔
紅色引线插"+"号口,黑色引线插"-"号口。

3. 極性鍵(POLARITY SWITCH)——若你的电錶裝有極性
鍵,將其轉至你要測的电压類型(直流DC或交流AC),若
測直流电之电压要轉至+DC處。在某些特別情況要測直流
电負电压時才轉至"DC-"。若"AC volts"及"DC volts"也在电
的範圍鍵上時,一定要选正確的範圍來应对被測的电压
類型。

4. 操作範圍鍵(FUNCTION-RANGE SWITCH)——轉至最
高电压範圍。当你測任何电压時一定要做這一步驟。除
非你確实知道被測的电压不会超过你选的範圍。

5. 电錶接连(CONNECTING THE METER)——為人体安全
在接连电錶至电路時必須將电源切斷,引线要跨接
被測的电流部位(即要並联)。在直流电測量,將黑色引
接在电路最具負極性的点,紅色引线接在电路最具正極
的点。若你不能確定接在那一極性点,請教老師。

6. 电路接通(CIRCUIT ON)——若指針讀數在低刻度位置(刻
度表低數目,左處)則將範圍鍵轉換至低一級範圍直到指針
讀數在高刻度位置(刻度表高數目,右處)。注意,不可一次轉換
兩級範圍。

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7. 得到讀數後將电路切斷,移開电錶,將电錶関掉(off)及將範
圍鍵轉至最高範圍以保護电錶.

如同使用其他儀錶一樣地小心使用VOM, 注意下列事項:

当測电压時电路是接通的,所以將你一隻手放在口袋中,用另一隻
手來操作以求安全。若你用双手接电錶於电路上就如同將你自
已與电路並联而讓电流流过你的身体,会產生嚴重後果的。电流
很可能通过你的心臟,產生激烈的电擊致死。

尊重电氣,不要怕它!

若伏特电压錶與电路串联,全部的电流必通过电錶,因為电压錶内
裝有很高的电阻,則測出的电压幾乎與供应电压相近而造成錯誤的
讀數。

測电压時,不可將电錶定在測歐姆或千分之一安培上,你会損坏
电錶.

在學進一步的操作前,先做实験#1"用VOM測电压"。

資料三：INFORMATION SHEET 3

用VOM测电流

必須依下列程序使用VOM测电流。测毫安培（千分之一安培）的

代表性步驟如下：

1. 引线插入位置（LEAD PLACEMENT）——将引线插入適當的
輸入插口（input jacks）。测毫安培一般是接“+”及“-”插孔。
若要测电流的安培或百萬分之一安培時，应有其他插孔。

2. 極性鍵（POLARITY SWITCH）——此鍵应轉在DC+處
VOM一般不用来测AC电流。

3. 操作範圍鍵（FUNCTION-RANGE SWITCH）——轉此鍵至最
高範圍，此步驟必須完成，除非你確实知道被测的电流不
会超过你选的範圍。

4. 接連电錶（METER CONNECTION）——須讓所有经过組
的电流也通过电錶以利测量。為達此目的，要将电路
拆掉一段而将电錶插入使成串联型態。假設我们有
电路如圖一（Figure. 1），我们想测B点之电流。

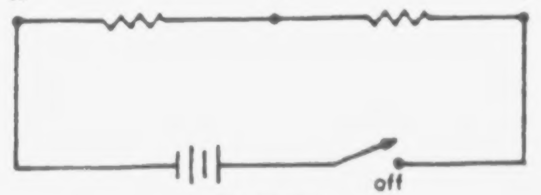


FIGURE 1

第一步——切断电源。

第二步 —— 拆掉在B奌的电路，如図二(Figure 2)

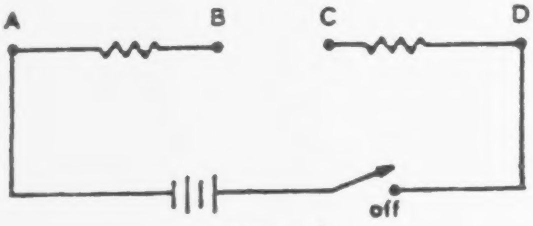


FIGURE 2

第三步 —— 以电錶負極引线接在电路的負極路线(本例為
B奌)，正極引线接在电路的正極路线(如：C奌
請老師驗查你
的接线是否正確。(図三)
(Figure 3)

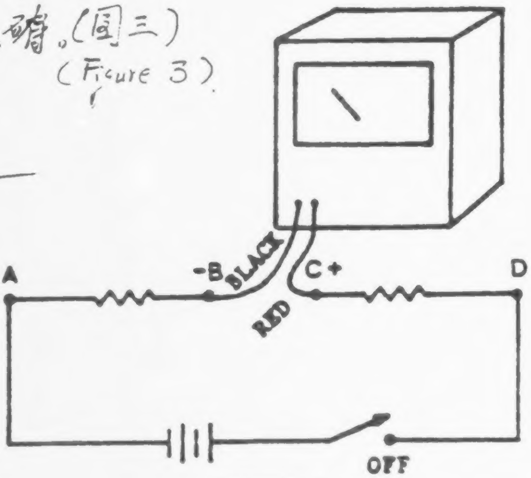
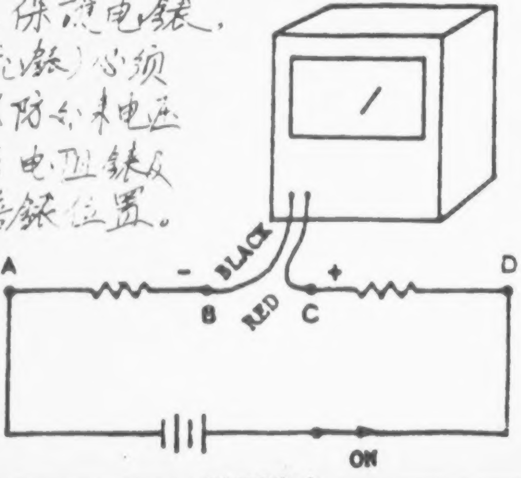


FIGURE 3

5. 接通电路(CIRCUIT ON)——
电路通电，测流过电路的
电流。若指針停在刻度本
低讀數處，則將範圍鍵
一级一级地降低直到指針
停在表中间或高數值處，
則讀出你的數值(図四)
(Figure 4)

6. 切断电路(CIRCUIT OFF)—— 切断电路，移開电錶。将电錶关
掉(off)或轉最高电压範圍，以保護电錶。
用歐姆錶(电阻錶)及安培錶(电流錶)必须
將範圍鍵轉至最高电压範圍，以防突來电压
損壞电錶。只当你要用电錶作电阻錶及
安培錶時要轉至歐姆錶及安培錶位置。
否则都必须將电錶轉至関(off)
位置，或轉至最高电压範圍
處以保護电錶。



电流錶绝不可与电路上任何组件成並联連接，因為电流錶内的电阻十分小，若並联連接则有如电路中有一條短路(shorted circuit)，则大量电流通过电錶，使得指針旋轉軸受損，因為其只能接受很小的电流。

資料第四：INFORMATION SHEET 4

用VOM測电阻

当用VOM錶測电阻時，必須依照下列程序：

1. 引线插置(LEAD PLACEMENT)——將引线插入適当的輸入插口，即"+"及"-"插孔如同測其他电氣一樣。

2. 極性鍵(POLARITY SWITCH)——轉至"DC+"位置，若轉在AC或"DC-"處，则电錶不能正常運作。

3. 电錶歸零(METER ZERO)——測电阻時电錶的指針必須在刻度左、右兩側均能停在零点。VOM具有最高电阻以讓最少电流通过。高电阻讀數在刻度表左側。VOM一般在左側与調整。电錶歸零是讓操作者設定电阻是零時以便絶大部份的电流能通过。

   零点調整如下：

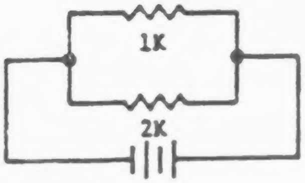
   第一步：轉範圍鍵至所選的範圍，將兩引线相接觸(即短路

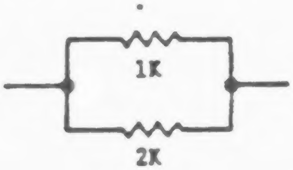
   第二步：旋轉零点調整鈕(zero adjustment)使指針停在歐姆刻度的零讀數位置。

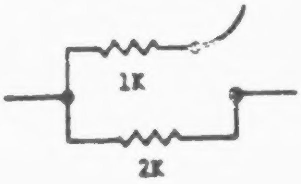
第三步：分開引綫，不能讓引线相接觸太久，会把电錶内的
电池耗用掉。

4. 操作範圍鍵（FUNCTION-RANGE SWITCH）—— 測电阻時可以讓此鍵轉至任何位置，其範圍等級是成倍數分級的，將由刻度表讀得之數值乘以选定範圍標示的倍數即得真正的电阻值。例如：刻度表讀得 2.2，选定的範圍標示為 R×100，則以 2.2 乘 100 得 200.（VOM的範圍級數有限，所以比 VTVM电錶所能測的要小）.

5. 拆离电阻器（DISCONNECT RESISTOR）——任何要測的电阻器必需拆离电源以防受損而能得正確讀數。假設电路圖如下：若你欲測 1K 的电阻器，不但要切断电源而且还要拆离电阻器，以得單獨 1K 电阻器的測量







6. 讀电錶刻度並乘以选定範圍的倍數，若必要則記錄下來。（若要得較精準的讀數，則另选定新範圍，但必須再度歸零調整）.

7. 当得到數值後，將电錶關掉（OFF）或轉至最高电压範
以保護电錶。

EL-IC-04

儀錶（电錶）METERS

資料摘要 INFORMATION SUMMARY

VOM是一种多功能的儀器。某製造商宣稱有1001种。它像許多其他儀器一樣不需要外來的电源而適合在室外現場或工作间裏使用。

VOM用以测量电流，电压及电阻。

测量电流時，电錶必须与被测点的电路接成串联。即錶的正極接电路的正極，錶的負極接电路的負極（觀测極性）。电錶要定在最高电流範圍以保護电錶。你絕不能将电錶与电路並联連结。一定要串联以使全部电流流经电流錶。

测量电压時，电錶必须与被测点的电路接成並联。錶要定在最高电压範圍以保護电錶。錶的正極与电路正極相接。錶的負極与电路負極相接。

测量电阻時，先要将电路的每個电源均切断，以保護电錶。被测电阻器一端电路必须切断而只测該电阻器的电阻。

VOM被設計测量直流电流（DC current），交流及直流电压（AC and DC Voltage）及电阻（Resistance）。若正確地使用，VOM是工作間内最有效的电錶。你必须記住，若电錶使用不當，則会像其他精密儀器一樣失去效率。

EL-IS-04

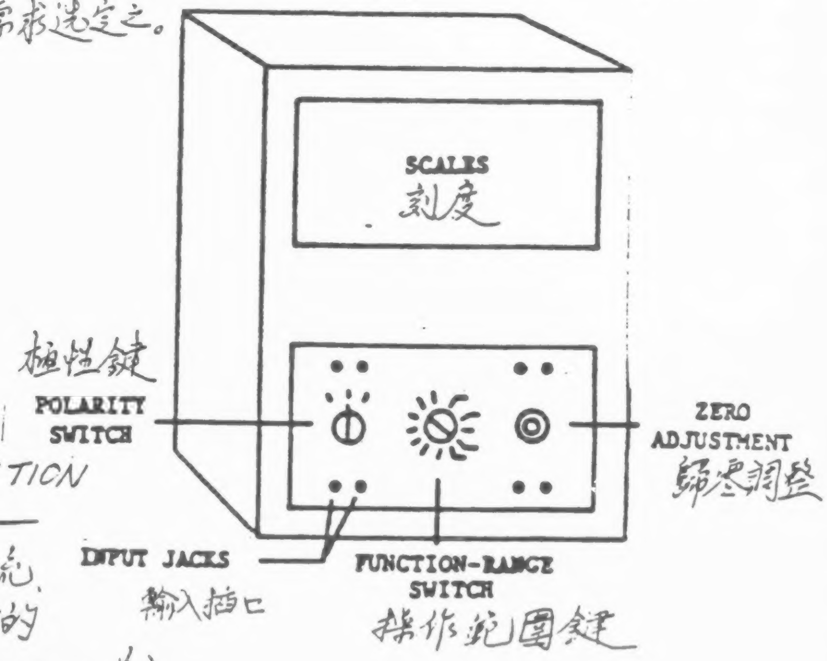
資料一：INFORMATION SHEET 1

伏特—歐姆—千分之一安培（VOLT-OHM-MILLIAMMETER）电錶通論。

商用型伏特—歐姆—千分之一安培电錶（Volt-Ohm-Milliammeter, VOM）能测交流及直流电压，直流电流及电阻。有時其他功能也會被設計進。

大多數VOM有許多共同特点：

1. 極性鍵（POLARITY SWITCH）—用以选擇+DC，−DC或AC 依你欲測量類型需求选定之。（如圖例）


SCALES
刻度
極性鍵
POLARITY SWITCH
ZERO ADJUSTMENT
歸零調整
INPUT JACKS
輸入插口
FUNCTION-RANGE SWITCH
操作範圍鍵

2. 操作範圍鍵（FUNCTION-RANGE SWITCH）—选擇使用類別（电流、电压或电阻）及測量的範圍（如100 ma或10 ma等）每次只能选一种範圍來使用.

3. 歸零調整（ZERO ADJUSTMENT）——（有時稱為零歐姆 zero ohms）在电阻計（錶）（ohmmeter）内电路上的一個可变电阻器，用以測电阻時調整儀錶内电池的电压。选任何一电阻範圍均要調整。当电阻錶的兩支引线（leads）相接觸，使錶上指針指零（通常在錶右側）。此時因無电阻在此兩支引线之间，則电阻錶必須指零。每选一次範圍均需歸零調整。

4. 輸入插口（INPUT -JACKS）——测量引线插入电錶的孔。孔邊有標明"+"及"-"(或 common)。若有疑问則查閱操作手册。

5. 电錶刻度（METER SCALES）——有如半圓規的边被分隔成許多小刻度用以讀出數值。

6. 测量引线（TEST LEADS）——接連儀錶與被测组件的电线，紅色引线代表正極"+"，黑色引线代表負極"-"(共同 common 極)。接連引线時要注意其極性，在直流电路应用上，錯接極性会使指針旋轉軸扭彎或倒轉而損坏电錶。在交流电路上極性則不重要。

所有 VOM 均為十分靈敏的电錶，测不同的电压及电流時要变換其测量範圍及操作种類。

只需测量之电流達五千萬分之一安培（0.00005 A 或 50 micro A）就可使 VOM 的指針旋轉。所以若电錶使用不当会很快地受損。所有的儀錶均是設定在正確使用的條件下設計的。每具 VOM 电儀价值 $100.-(若是由於你錯誤使用，則你要負責)。VOM 电錶会使电路电流有些微下降，即可以說是 VOM 电錶电路的电負荷。在某些电路上此电負荷是很顯着的。這也是测量時發生誤差的原因之一。在高电阻电路上或电錶選在低範圍時，此种电負荷最明顯。

EI-IC-04

資料二：INFORMATION SHEET 2

下面解説用VOM电錶測电压的一般程序，其適用於大多數电錶只有少數例外。

1. 為使电錶讀量精確。其电錶尚未接电路時其指針須在刻度左側零点處。若否，請知道如何歸零調整的人來調整。

2. 引线插孔（LEAD PLACEMENT）——將引线插入正確的插孔。紅色引线插"+"号口，黑色引线插"−"号口。

3. 極性鍵（POLARITY SWITCH）——若你的电錶装有極性鍵，將其轉至你要測的电压類型（直流DC或交流AC），若測直流电之电压要轉至+DC處。在某些特别情况要測直流电負电压時才轉至"DC−"。若"AC volts"及"DC volts"也在电錶的範圍鍵上時，一定要选正確的範圍來应对被测的电压類型。

4. 操作範圍鍵（FUNCTION-RANGE SWITCH）——轉至最高电压範圍。当你測任何电压時一定要做這一步驟。除非你確实知道被测的电压不会超过你选的範圍。

5. 电錶接連（CONNECTING THE METER）——為人体安全，在接連电錶至电路時必須將电源切斷。引线要跨接在被測的电流部位（即要並联）。在直流电測量，將黑色引线接在电路最具負極性的点，紅色引线接在电路最具正極的点。若你不能確定接在那一極性点，請教老師。

6. 电路接通（CIRCUIT ON）——若指針讀數在低刻度位置（刻度表低數目，左處）則將範圍鍵轉換至低一級範圍直到指針讀數在高刻度位置（刻度表高數目，右處）。注意，不可一次轉換兩級範圍。

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7. 得到讀數後将电路切斷，移開电錶，将电錶的 [illegible] 將範圍鍵轉至最高範圍以保護电錶。

如同使用其他儀錶一樣地小心使用VOM，注意下列事項：

当测电压時电路是接通的，所以将你一隻手放在口袋中，用另一隻手来操作以求安全。若你用双手接电錶於电路上就如同将你自己与电路並联而讓电流流过你的身体，会產生嚴重後果的。电流很可能通过你的心臟，產生激烈的电擊致死！

尊重電氣，不要怕它！

若伏特电压錶与电路串联，全部的电流必通过电錶，因為电压錶内装有很高的电阻，则测出的电压幾乎与供应电压相近而造成錯誤的讀數。

测电压時，不可将电錶定在测歐姆或千分之一安培上，你会損坏电錶。

在學進一步的操作前，先做实验#1"用VOM测电压"。

資料三：INFORMATION SHEET 3

用VOM测电流

必須依下列程序使用VOM测电流，测毫安培（千分之一安培）的代表性步驟如下：

1. 引线插入位置（LEAD PLACEMENT）——将引线插入適當的输入插口（input jacks），测毫安培一般是接"+"及"-"插孔。若要测电流的安培或百萬分之一安培時，应有其他插孔。

2. 極性鍵（POLARITY SWITCH）——此鍵应轉在DC+處。VOM一般不用来测AC电流。

3. 操作範圍鍵（FUNCTION-RANGE SWITCH）——轉此鍵至最高範圍，此步驟必須完成，除非你确实知道被测的电流不会超过你选的範圍。

4. 接連电錶（METER CONNECTION）——須讓所有经过组件的电流也通过电錶以利测量。为達此目的，要将电路线拆掉一段而将电錶插入使成串联型態。假設我们有一电路如图一（Figure. 1），我们想测B点之电流。

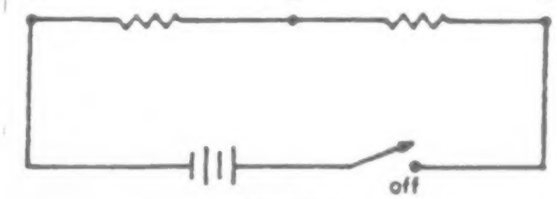


FIGURE 1

第一步：——切断电源。

第二步 —— 拆掉在B点的电路 如图二(Figure 2)

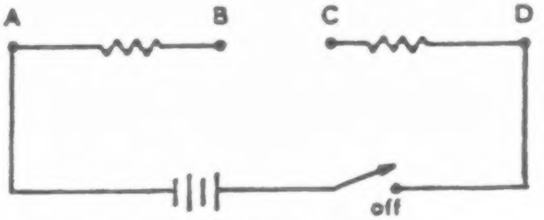


FIGURE 2

第三步 —— 从电錶负極引线接在电路的负極路线(本例為B点)，正極引线接在电路的正極路线(如:C点)
請老師驗查你
的接線是否正確。(図三)
(Figure 3)

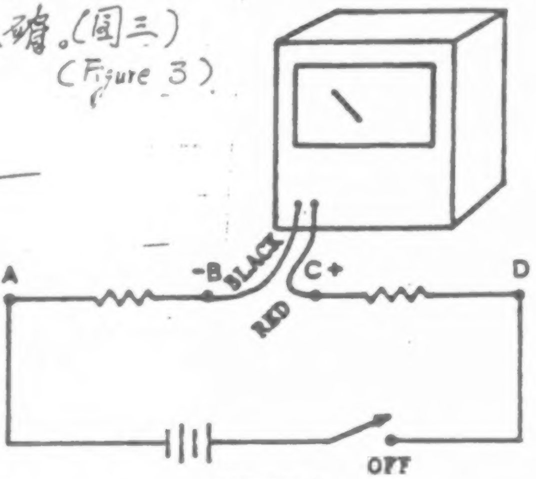
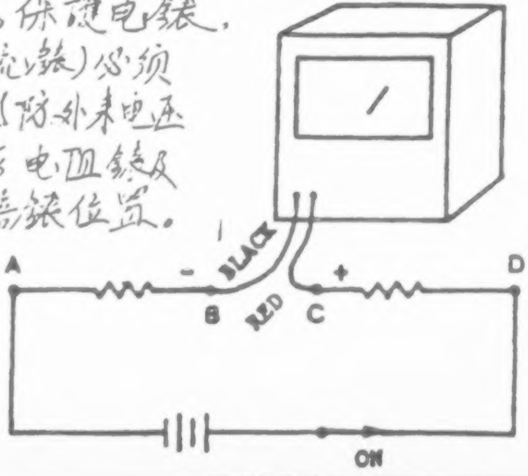


FIGURE 3

5. 接通电路(CIRCUIT ON) —— 电路通电，测流过电路的电流。若指針停在刻度本低讀數處，則將範圍鍵一級一級地降低直到指針停在表中间或高數值處，則讀出你的數值(図四)
(Figure 4)

6. 切断电路(CIRCUIT OFF) —— 切断电路，移開电錶，將电錶関掉(off)或轉最高电压範圍，以保護电錶。
用歐姆錶(电阻錶)及安培錶(电流錶)必须將範圍鍵轉至最高电压范圍，以防外来电压損坏电錶。只当你要用电錶作电阻錶及安培錶将再轉至歐姆錶及安培錶位置。否則都必须將电錶轉至関(off)位置，或轉至最高电压範圍處以保護电錶。



电流錶绝不可与电路上任何组件成並联連接。因为电流錶内的电阻十分小，若並联連接则有如电路中有一條短路(shorted circuit)，则大量电流通过电錶，使得指针旋轉軸受損，因为其只能接受很小的电流。

資料第四：INFORMATION SHEET 4

用VOM測电阻

当用VOM錶測电阻時，必須依照下列程序：

1. 引线插置(LEAD PLACEMENT)——将引线插入適当的輸入插口，即"+"及"-"插孔如同測其他电氣一樣。

2. 極性鍵(POLARITY SWITCH)——轉至"DC+"位置，若轉在AC或"DC-"處，则电錶不能正常運作。

3. 电錶歸零(METER ZERO)——測电阻時电錶的指针必須在刻度左、右兩側均能停在零点。VOM具有最高电阻以讓最少电流通过。高电阻讀數在刻度表左側。VOM一般在左側与調整。电錶歸零是讓操作者設定电阻是零時以使绝大部份的电流能通过。
   零点調整如下：
   第一步：轉範圍鍵至你选的範圍，將兩引线相接觸(即短路)

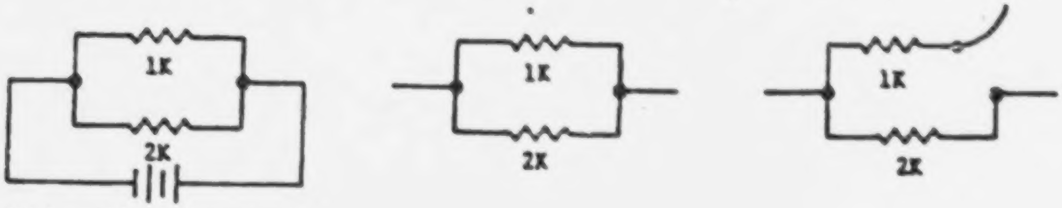
   第二步：旋轉零点調整鈕(zero adjustment)使指针停在歐姆刻度的零讀數位置。

E1-10-04

第三步：分開引綫，不能讓引綫相接觸太久，会把電錶內的电池耗用掉。

4. 操作範圍鍵（FUNCTION-RANGE SWITCH）——測电阻時可以讓此鍵轉至任何位置，其範圍等級是或倍數分級的，將由刻度表讀得之數值乘以選定範圍標示的倍數即得真正的电阻值。例如：刻度表讀得2.2，選定的範圍標示為R×100，則以2.2乘100得220.（VOM的範圍級數有限，所以比VTVM电錶所能測的要小）.

5. 拆离电阻器（DISCONNECT RESISTOR）——任何要測的电阻器必需拆离电源以防受損而能得正確讀數。假設电路圖如下：若你欲測1K的电阻器，不但要切斷电源而且还要拆离电阻器，以得單獨1K电阻器的測量。



6. 讀电錶刻度並乘以選定範圍的倍數，若必要則記錄下來。（若要得較精準的讀數，則另選定新範圍，但必須再度歸零調整）.

7. 當得到數值後，將电錶關掉（off）或轉至最高电压範圍以保護电錶。

ELECTRONIC CURRI M

VOCATIONAL TRAINING LE V .AN / V   Nature of Electricity

nching Materials Source ______________________
apter ______________, pages ______________
b Manual pages ______________
ditional Instructor Materials ______________________

in concepts student will learn:

e student will be able to:

differentiate and identify the basic parts of the atom, and the fundamental laws of charged bodies.

explain the definition for both voltage and current, and indicate the proper units of measurement for each quantity.

demonstrate the ability to connect a simple electrical circuit together, and to state the purpose of the individual components referred to as the supply, control, conductor, and load.

Technical Vocabulary

see Glossary

Related General Vocabulary

Teaching Activity

1. Obtain a three foot acrylic tube with a diameter slightly larger than a ping-pong ball. Dill the tube (conductor) and perform a variety of demonstrations. Insert one ball in and observe the "chain reaction" which will culminate with one ball exiting the opposite end of the tube. Apply a force (voltage) by blowing into the tube and observe the internal flow. Finally, insert a color ball into one end of the tube and as succeeding balls pop out keep inserting them into the opposite end while watching the colored ball travel through the tube. Discuss electron flow in terms of this demonstration.
2. If possible obtain a wall chart of the periodic table of the elements and utilize it during the presentation on the basic structure of the atom. Check with other departments for a possible loan of this visual aid.

ngth of Lesson

week

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

Materials and Notes

Students are working on Nature of Electricity while they are also working on projects they started in Unit III.

Instructor References:

Basic Principles of Electricity. Vester Robinson, Reston Publishing Company, 1973. Chapter: 1.

Electronic Communication. Robert L. Shrader, McGraw-Hill Book Company, 1975. Chapter: 1.

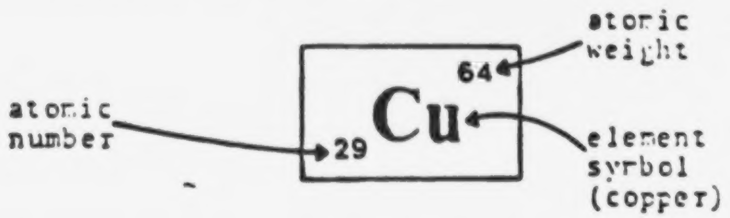
Fundamentals of Electricity. Robert Seippel, American Technical Society, 1974. Chapters: 1 and 2.

Date: ____________

NATURE OF ELECTRICITY Period: ____________

TECHNICAL GLOSSARY

AMPERE:	The basic unit of measurement for current. Abbrev. A
ATOM:	The smallest particle that an element can be divided into, and still have all the characteristics of that element. For example: the smallest possible bit of copper, that can be removed from a penny would be an atom of copper. Atoms contain three basic particles - protons, electrons, and neutrons.
ATOMIC NUMBER:	One of two numbers appearing by each element of the "periodic table." The atomic number is the smaller of the two numbers, and indicates the total number of protons in the nucleus of the particular atom. Example:



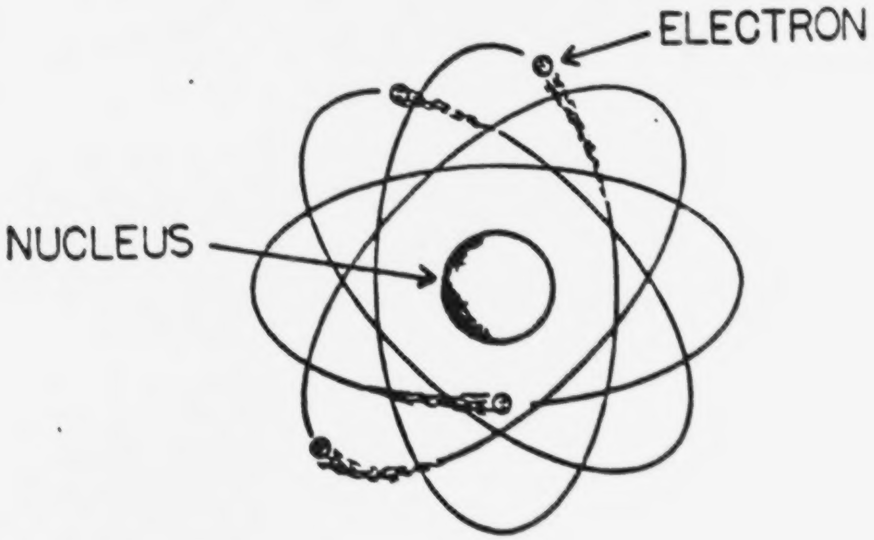
ATOMIC WEIGHT:	The second of two numbers appearing with each element on the "periodic table." The atomic weight indicates the total mass of the nucleus of the atom.
COMPLETE CIRCUIT:	An electrical circuit which contains at least a; supply, load, control, and conductor. All functional electrical circuits must contain these 4 basic parts.
CONDUCTOR:	A material which freely allows current to flow through it Example: copper, aluminum, and silver are conductors.
CONTROL:	The part of a complete circuit which turns on, turns off, or routes (directs) current through a circuit. A switch is an example of a control.
CURRENT:	The orderly flow of electrons through an electrical circuit. Abbrev. I.
ELECTRON:	The negatively charged particle in an atom. The electron are located in the "shells," and orbit around the nucleus
ELECTRON SHELL:	The location of the electrons within the atom. Each layer of electrons constitutes a shell, and each shell has a maximum population.
LOAD:	The device which a circuit is designed to operate. Comm circuit loads are motors, lamps, speakers, heating elements, etc.

Name: ______________

Date: ______________

Period: ______________

NEUTRON:	An atomic particle located in the nucleus of the atom and is neutral (neither positive nor negative) in charge.
NUCLEUS:	The center mass of an atom, which contains the protons an neutrons. The nucleus forms the central "core" of the atom, and also contains the majority of the atom's mass.
PROTON:	An atomic particle, located in the nucleus of the atom, and having a positive charge.
SUPPLY:	The device which provides, or supplies, the necessary voltage and current for circuit operation. Some typical supply devices are batteries, generators, and solar cells The supply is often refered to as the source.
VALENCE SHELL:	The outer most electron shell of the atom, also referred to as the "hook". The valence shell is the most chemically and electrically active of the electron shells. I is the valence electrons which basically determine a materials electrical characteristics.
VOLT:	The basic unit of measurement for voltage. Abbrev. V
VOLTAGE:	The electrical force or pressure which causes electr to move through a circuit. Other terms for voltage electromotive force and potential difference. Abbrev.



SCORE:

GRADE:

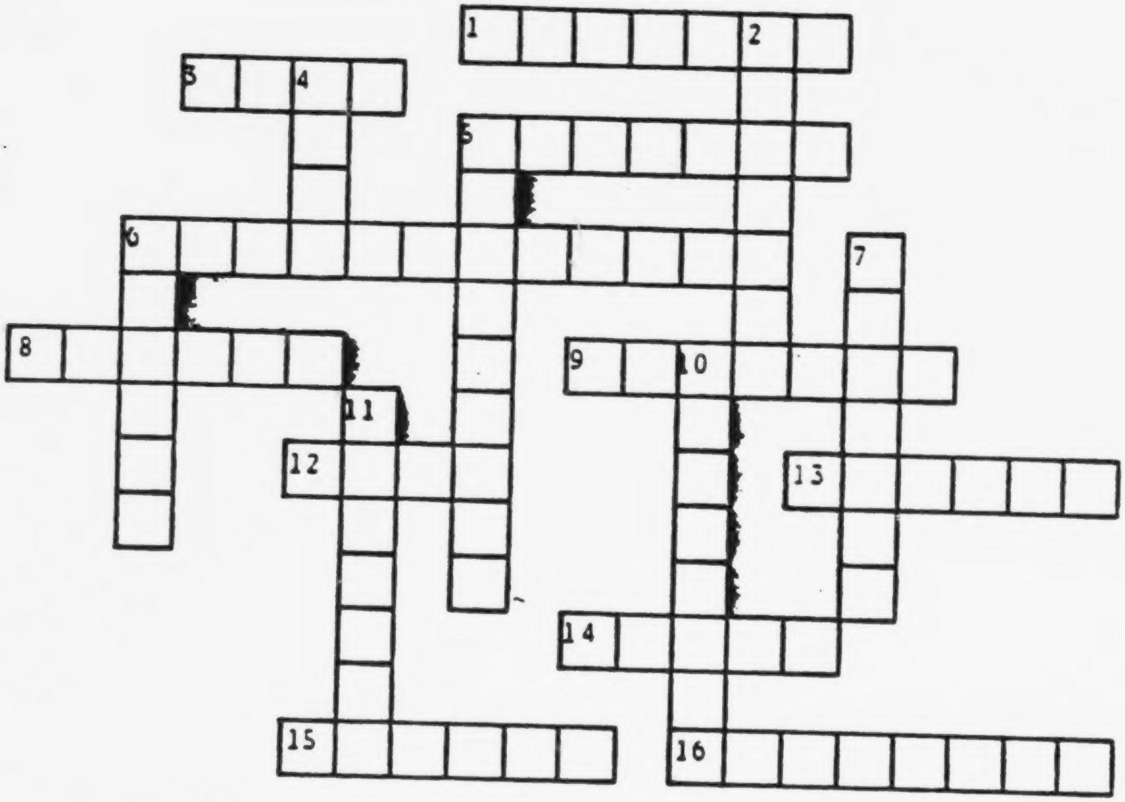
Name: ______________________

Date: ______________________

Period: ______________________

WORKSHEET

VOCABULARY - CROSSWORD PUZZLE



ACROSS

1. The outer most electron shell.
3. The device a circuit is designed to operate.
5. The orderly flow of electrons through a circuit.
6. Identifies the number of protons in an atom.
8. The part of a circuit which provides the voltage and current for operation.
9. The center of the atom.
12. The basic unit for voltage.
13. The positive particle in the nucleus of the atom.
14. The location of electrons in an atom.
15. The atomic ______________ indicates the mass of an atom.
6. The negative particle in an atom.

DOWN

2. The part of a complete circuit which "directs" current flow.
4. The smallest particle into which an element can be divided.
5. A material which allows, or supports current flow.
6. The basic unit for current flow.
7. A neutral partical in the center of the atom.
10. An electrical circuit which contains a supply, load, control, and conductor
11. Electromotive force.

SCORE:

GRADE:

Name: __________

Date: __________

Period: __________

WORKSHEET

QUEST ACTIVITY

"UNIT 6"

1. Electrons orbit around the nucleus of the atom in paths called __________.

1.

2. The nucleus of the atom contains both A) __________ and B) __________.

2A.

2B.

3. The atomic __________ indicates the number of protons in the atom.

3.

4. A neutral atom will contain the same number of A) __________ and B) __________.

4A.

4B.

5. The outer most electron shell of an atom is called the __________ shell.

5.

6. Electromotive force is commonly called A) __________ and is measured in the basic unit of the B) __________.

6A.

6B.

7. The orderly flow of electrons through a circuit is called A) __________ and is measured in the basic unit of the B) __________.

7A.

7B.

8. The smallest particle that an element can be divided into, and still retain all its characteristics is called an __________.

8.

9. Unlike electrical charges will A) __________ while like electrical charges B) __________.

9A.

9B.

10. A positively charged particle will attract both a A) __________ charged or B) __________ particle.

10A.

10B.

11. List the three basic atomic particles, and their electrical charges.

PARTICLE		CHARGE
	- - -	
	- - -	
	- - -	

Name: ____________

Date: ____________

Period: ____________

12. Draw a sketch of the boron atom.

Boron $_{5}\text{B}^{11}$

13. Draw a sketch of the copper atom.

Copper $_{29}\text{Cu}^{64}$

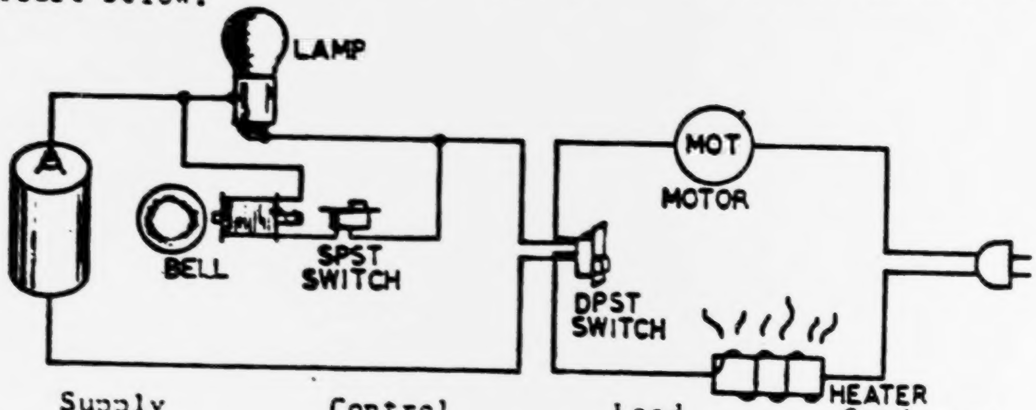
14. Draw a diagram of a simple complete electrical circuit. *Label the four characteristic parts of the circuit.*

Name: ____________________

Date: ____________________

Period: ____________________

15. Identify the supply, control, load, and conductor elements in the circuit below.


LAMP
A
BELL
SPST SWITCH
MOT
MOTOR
DPST SWITCH
HEATER

Supply Devices	Control Devices	Load Devices	Conductor Element

Name: ________________

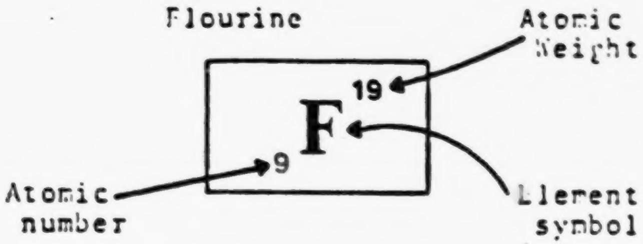
Date: ________________

Period: ________________

INFORMATIONAL HANDOUT

STRUCTURE OF THE ATOM

INFORMATION FOUND ON PERIODIC TABLE:



DRAWING AN ATOM:

To draw an atom you must know the number of protons, electrons, and neutrons present in the atom. The atomic number provides part of this information - it indicates the number of protons found in the nucleus of the atom. In their pure form, an atom will have an equal number of protons and electrons, so the atomic number actually indicates the total number of protons or electrons. To find the number of neutrons in the atom, simply subtract the atomic number from the atomic wei t.

Using the information given about the flourine atom, you should then be able to list the number of protons, electrons, and neutrons found in that atom.

Protons - 9

Electrons- 9

Neutrons - 10

Once the above information is determined a simple sketch of the atom can be made as follows:

1) Draw the protons and neutrons in the nucleus of the atom, which is located in the center of the diagram.

2) The electrons orbit around the nucleus, and are located in the electron shells. Each shell has a maximum population, as follows:

1st shell	2nd shell	3rd shell	4th shell
2 electrons	8 electrons	18 electrons	32 electrons

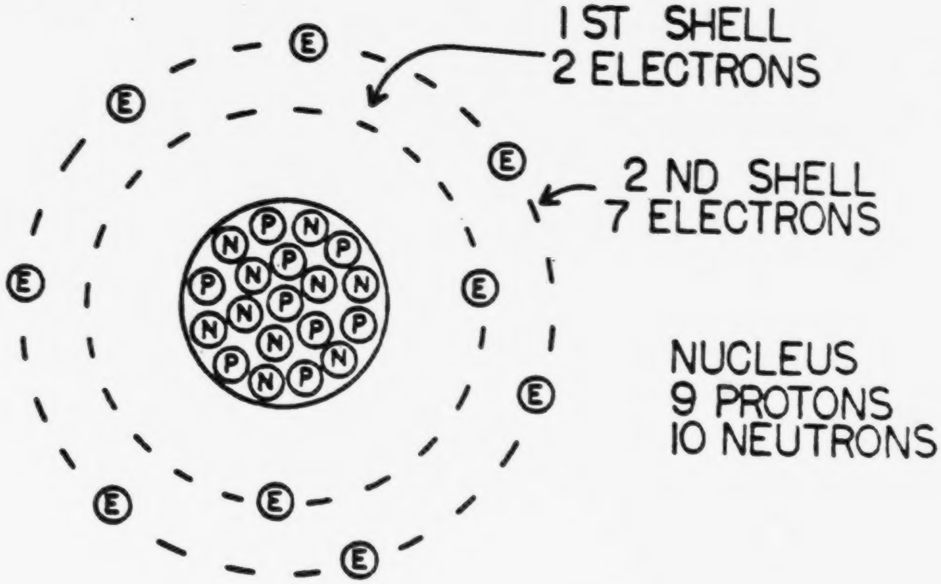
The electrons must then be placed in the shells, beginning with sh l #1, filling each shell before moving to the next.

Name: ____________________

Date: ____________________

Period: ____________________

Flourine Atom


1 ST SHELL
2 ELECTRONS
2 ND SHELL
7 ELECTRONS
NUCLEUS
9 PROTONS
10 NEUTRONS
E
P
N

Now that you know the system, use your new knowledge to draw a sketch of the lithium atom.

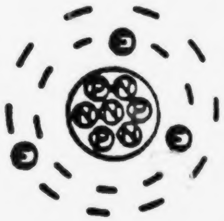
$_{3}\mathrm{Li}^{7}$

Protons -

Electrons-

Neutrons -

Compare your answers with the sketch below.



WIRING A CIRCUIT

Lab Sheet #4

OBJECTIVES

To develop skills in connecting and testing simple circuits
To learn the schematic symbols for simple circuits
To learn to connect and test a one-way and a two-way switch circuit

INTRODUCTION

An example of a complete circuit consists of these four things:

(1) A power source, such as a battery or power supply.

(2) A load, such as a lamp or motor.

(3) Conductors, such as wires or metal strips.

(4) A switch to turn the circuit "on" and "off".

MATERIALS

Continuity Board (Same board used in Lab Sheet #1)
DMM
Variable D.C. Power Supply
Clip leads

PROJECT 1: Wiring and Testing a Switched Lamp Circuit

INSTRUCTIONS

1. Use a clip lead to wire together the lamp and switch as shown. You need only one lead to do this for now. Points A and B will be the two ends of the circuit. Later a power supply will be connected to these points.

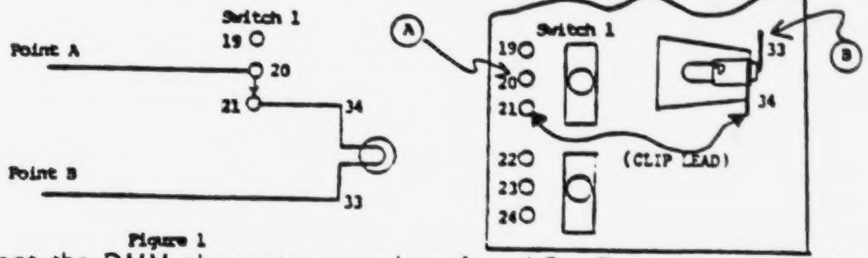


Figure 1

2. Connect the DMM ohmmeter to points A and B. Turn the switch(S1) "on" and "off" and record the ohmmeter measurements. (Remember that when the switch is "off", the circuit is OPEN (infinite ohms). When the switch is "on", the lamp resistance should be read on the DMM ohmmeter.)

"ON": __________ohms. "OFF": __________ohms.

3. Disconnect the ohmmeter if you read the lamp resistance when the switch is "on", and infinite ohms when "off". Finally, turn switch(S1) "off". The circuit is now ready for power to be applied.

4. Before connecting the power supply to the circuit, turn the power supply "on" and set the "A" SUPPLY for 15 volts. Turn the power supply "off" after setting the voltage.

5. Make sure the ohmmeter has been removed from points "A" and "B". Using banana plug leads, connect the "A" SUPPLY "+" to point "A" of the lamp circuit. Connect the "A" SUPPLY "-" lead to point "B".

6. Turn the power supply "on". Turn the lamp circuit switch(S1) "on". The lamp should light dimly, as it is a 28 volt lamp. (Did you think we were going to trust you this soon with a 12 volt lamp and a 20 volt power supply?!)

7. Does the lamp light when the circuit switch(S1) is "on"? YES/NO
Does the lamp not light when the circuit switch(S1) is "off"? YES/NO

8. Turn the power supply and circuit "off".

9. How have you done so far? (circle one.)

Fantastic. / O.K. / I'm considering changing my "major" to buggy repair.

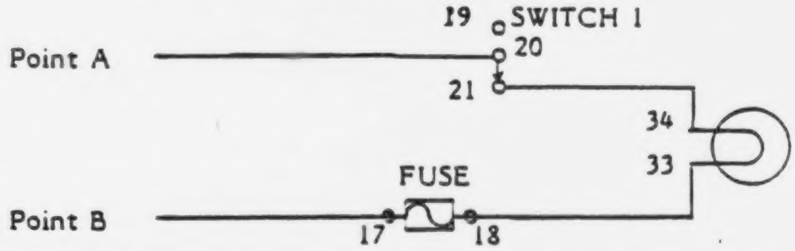
PROJECT 2: Wiring a Fuse Protected Lamp Circuit.

INTRODUCTION

In this project, you will add a fuse to the same lamp circuit you just wired and tested. Be sure you have read about fuses in your textbook. The purpose of the fuse is to open the circuit in the event of a short and excessive current. The fuse will not affect the normal operation of the circuit.

INSTRUCTIONS

1. Use a clip lead to connect the fuse in the circuit where shown. (That is, connect a clip lead from SWITCH 1 [terminal 20] to the fuse [terminal 18]). Point "B" now will be at fuse terminal 17.



2. Be sure the power supply is not connected to the circuit for this step. Connect the ohmmeter to circuit points "A" and "B" shown above. Test the circuit with the ohmmeter as done before.

S1 "ON": _________ ohms.   S1 "OFF": _________ ohms.

3. Disconnect the ohmmeter if you read the lamp resistance when the switch is "on", and infinite ohms when "off". Finally, turn switch(S1) "off". The circuit is good, and ready for power to be applied.

4. Connect the power supply to points "A" and "B" above. Test the circuit as done before.

5. Does the lamp light when switch(S1) is "on"? YES/NO
Does the lamp not light when switch(S1) is "off"? YES/NO

6. How are you doing so far? Great. / So - so. / Not so good.

PROJECT 3: Wiring a Dual Switched Lamp

INTRODUCTION

In this project you will wire a model circuit like that which is in a long hallway. The lamp can be turned both "on" and "off" from either end of the hallway. You will be using both of the SPDT switches (Switch #1 and #2) and the lamp. You will be given fewer instructions. Follow the wiring diagram carefully. Check the circuit with the ohmmeter before you connect the power supply to insure it is connected properly. See if you can make it work the first time power is applied.

INSTRUCTIONS

1. Connect the circuit shown below.

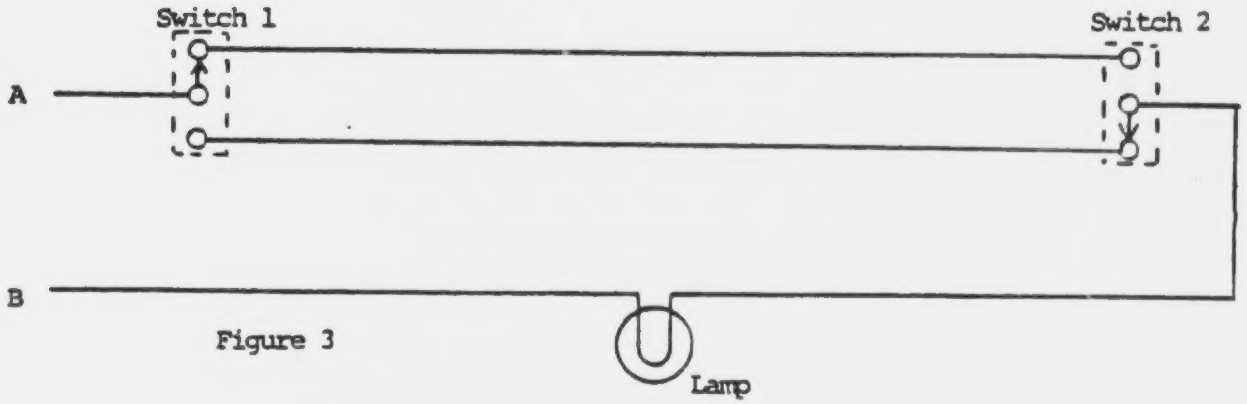


Figure 3

2. Connect the ohmmeter to points "A" and "B" and check your circuit by operating both switches as required. (NOTE: A switch is "on" when the circuit is completed from points A to B. When both switches are "on", an ohmmeter connected to points A and B should measure the lamp resistance.)

3. If the circuit checks out all right, disconnect the ohmmeter. Connect the power supply (15 volts) to points "A" and "B". Check the operation of the circuit this way:

Make sure the lamp is "off". Imagine the switches are at the opposite ends of a long dark hallway and the lamp is in the middle. Two people will enter the hallway 15 minutes apart. They will enter at the Switch #1 end and exit at the Switch #2 end. Each person will turn the lamp "on" with Switch #1 as they enter the hallway. Each will turn the lamp "off" with Switch #2 as they leave the hallway.

4. How did you do? (check one.)

____ The circuit worked perfectly!

____ The circuit worked partially.

___ The circuit did not work.

5. If your circuit works correctly, study the schematic for the best place to put a fuse. The fuse must be in the circuit at all times, no matter how the switches are set. Draw the fuse on your schematic.

6. Connect the fuse in the circuit where you drew it.

7. Test the operation of the circuit with the fuse in the circuit now.

Does the circuit work correctly? YES/NO

Can both lab partners wire and test these circuits? YES/NO

SUMMARY

You should have observed these things about these simple circuits:

a. A switch turns a lamp "on" and "off" by "closing" and "opening" the circuit: When the switch is "off" - that is, when the circuit is "open" - no current can flow in the circuit anywhere. The lamp does not light. The switch can be placed anywhere in the simple circuit and still turn the lamp "off" and "on".

b. A fuse is in a circuit to act like a switch if too much current flows. Too much current could cause hot wires and damage components, and possibly start a fire. A fuse "opens" by melting if too much current flows and must be replaced once it "blows". The fuse does not affect the operation of a circuit since it acts like a conductor with very low resistacne. Like the switch, the fuse can go anywhere in the simple circuit and still do its job.

c. Switches can be checked using an ohmmeter. When a switch is "on" it should measure 0 ohms. When it is "off" it should measure infinite ohms.

d. Fuses can be checked using an ohmmeter. A good fuse should measure 0 ohms. A fuse which has been "blown", by too much current passing through it and the circuit, will measure infinite ohms. A "blown" fuse usually indicates there is trouble in the circuit, such as a "short".

e. Wiring a more complex circuit, like the Dual Switched Lamp, requires careful attention to details. It is absolutely essential that the schematic be closely followed when wiring any circuit. It is good practice to check the circuit using an ohmmeter before applying power.

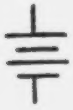
f. Each person must take the responsibility of getting the practice they need to become a skilled technician. Each semester many students fail to take this responsibility. After it is too late, they either fail or drop the course, or struggle through the rest of the program with poor skills. The most successful technicians in industry are people who eagerly improve their knowledge and skills at every opportunity.

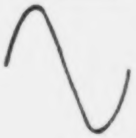
PROJECT 4: Self Evaluation Quiz (To be done outside of class time. If there is time remaining in the lab period, start Lab Sheet 5.)

INSTRUCTIONS

Select the schematic drawing for each word listed below. Mark the letter for the correct drawing after the appropriate word. Check your responses with those at the end of this quiz.

1. SPDT switch. ______
2. DPDT switch. ______
3. Power supply. ______
4. Fuse. ______
5. Lamp. ______
6. Conductors. ______


A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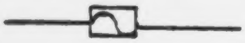
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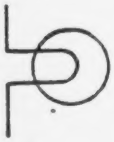
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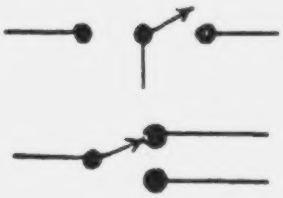

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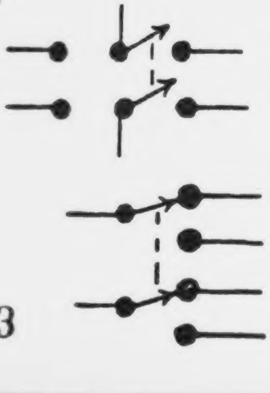

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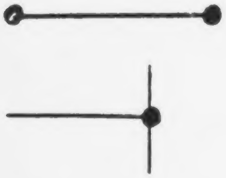
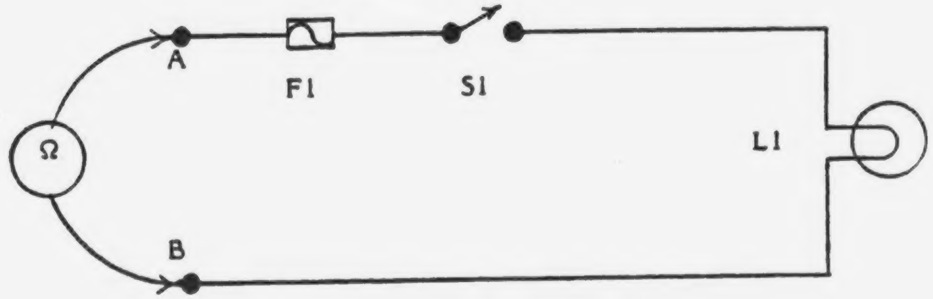


Complete the below statements by selecting the correct words.

7. Normally a simple circuit will consist of these four elements: ___.
    - a. Battery, conductors, load, and lamp.
    - b. Power source, load, conductors, and lamp.
    - c. Load, power source, switch, lamp.
    - d. Power source, conductors, switch, and load.
8. When a good fuse is checked with an ohmmeter, the resistance should be ___.
    - a. very low.
    - b. very high.
    - c. 2.5Kohms.
    - d. infinite ohms.
9. Before power is applied to a circuit, you should make sure that ___.
    - a. the power supply is not connected.
    - b. the circuit is not connected.
    - c. the ohmmeter is not connected.
    - d. the ohmmeter is connected.
10. The circuit in PROJECT 1 is not protected because it has no ___.
    - a. lock.
    - b. fuse.
    - c. fire extinguisher.
    - d. guard.
11. A simple lamp circuit can be checked for an "open" using a/an ___.
    - a. ohmmeter.
    - b. flashlight.
    - c. mirror.
    - d. ruler.

Use the schematic below to answer the troubleshooting questions which follow. Do not connect this circuit to find the answers. In each question indications of "a trouble" will be given. Study the schematic and determine which of the responses for that question could cause the indications given.



12. The ohmmeter reads infinite ohms with S1 "on" or "off". The trouble could be ______.

  a. the ohmmeter is shorted.

  b. S1 is shorted.

  c. L1 is shorted.

  d. L1 is open.

13. The ohmmeter reads infinite ohms with S1 "on" or "off". The trouble could be ______.

  a. The ohmmeter is shorted.

  b. L1 is shorted.

  c. F1 is shorted.

  d. F1 is "blown".

14. The ohmmeter reads infinite ohms with S1 "on" or "off". The trouble could be ______.

  a. S1 is open.

  b. S1 is shorted.

  c. F1 is shorted.

  d. L1 is shorted.

15. The ohmmeter reads zero ohms with S1 "on" and infinite ohms with S1 "off". The trouble could be ______.

a. S1 shorted.

b. S1 open.

c. F1 shorted.

d. L1 shorted.

16. The ohmmeter reads 70 ohms with S1 "on" or "off". The trouble could be ______.

a. S1 shorted.

b. L1 shorted.

c. F1 shorted.

d. F1 "blown".

17. After the ohmmeter is removed, a suitable power supply is connected to points A and B. However, the lamp does not light immediately. Possibly ____.

a. the ohmmeter is still connected.

b. F1 is shorted.

c. S1 is "off".

d. S1 is shorted.

18. Refer to question 17: With power applied properly and S1 "on", the lamp still does not light. One thing you could do to troubleshoot is ____.

a. tap L1 with a large hammer.

b. remove L1 from the circuit and check it with an ohmmeter.

c. check F1 in the circuit with an ohmmeter.

d. check L1 in the circuit with an ohmmeter.

19. Refer to question 18: You determine that L1 measures 70 ohms. Something you could do next is ____.

a. replace L1 with a higher resistance lamp.

b. turn off the power, remove F1, and check it with an ohmmeter.

c. leave the power "on" and check F1 in the circuit with an ohmmeter.

d. buy a new ohmmeter because you did "c" above.

?0. Refer to question 19: You find that the fuse from the circuit measures infinite ohms. You should ___.

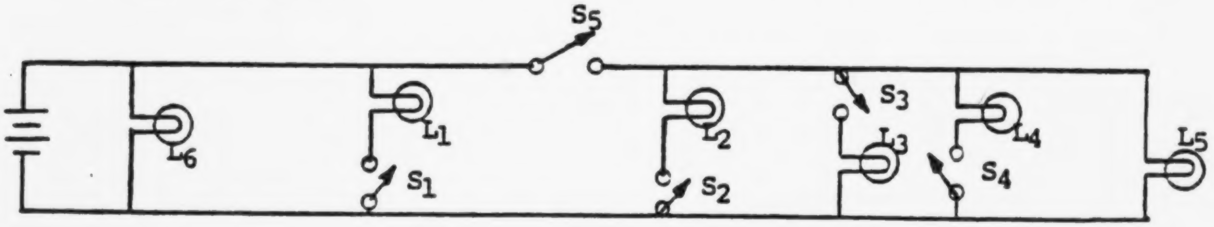
a. put it back in the circuit.

b. look for what caused F1 to "blow".

c. wrap metal foil around the fuse and put it back in the holder.

d. tap L1 lightly with a hammer.

Use the schematic below for questions 21 through 25. Select the correct answer for the conditions stated in each question. All lamps and switches are good, and there are no troubles in the circuit. All switches are "off" (open) unless stated otherwise.



21. S5 and S2 are "on" (closed). Which lamps are lit (on)?

a. L1, L2, L3, L4, and L5.

b. L1, L2, L3, L4, L5, and L6.

c. L2 and L5.

d. L2, L5, and L6.

22. S5, S1, and S4 are "on". Which lamps are not lit?

a. L1, L4, L5, and L6,

b. L1, L4, and L5.

c. L2 and L3.

d. L3, L5, and L6.

23. Which switches must be on to light L3, L5, and L6?

a. S3 and S5.

b. S1, S2, and S3.

c. S1, S2, S3, and S4.

d. S2, S3, S4, and S5.

24. Switches S2, S3, and S4 are "on". Which lamps are lit?

   a. L1, L2, L3, and L4.

   b. L2, L3, L4, L5, and L6.

   c. L2, L3, and L4.

   d. L6 only.

25. All switches are "on" except S5. Which lamps are lit?

   a. L1, L2, L3, and L4.

   b. L1, L2, and L3.

   c. L1 and L5.

   d. L1 and L6.

Answers to PROJECT 4: Self Evaluation Quiz

1. e.
2. f.
3. a.
4. c.
5. d.
6. g.
7. d.
8. a.
9. c.
10. b.
11. a.
12. d.
13. d.
14. a.
15. d.
16. a.
17. c.
18. b.
19. b.
20. b.
21. d.
22. c.
23. a.
24. d.
25. d.

Lab Experiment ____________ Name ____________________

Date ___________ Per. _____

CIRCUIT CONSTRUCTION

1. Construct a series circuit utilizing a 6 volt power supply, a SPST switch to control current flow, and two lamps as load devises.

Start Time ____________

End Time ____________

Grade ____________

SCHEMATIC DIAGRAM

2. Design a parallel circuit using the same parts as in Problem #1. Wire the circuit so that the switch will turn both lights on & off.

Start Time ____________

End Time ____________

Grade ____________

SCHEMATIC DIAGRAM

3. Design a series/parallel circuit consisting of two series lamps and two parallel lamps. The circuit opperates on 6 Vol. Wire the circuit so one switch will de-energize the whole circuit and another switch will controll one of the parallel lamps.

Start Time ____________

End Time ____________

Grade ____________

Test # __________

UNIT EXAM

NATURE OF ELECTRICITY

IMPORTANT

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. The atomic number indicates the number of neutrons in the atom. (T - F)

2. A neutral atom has as many electrons as it has protons. (T - F)

3. Basically, the atomic weight of an atom is equal to the number of neutrons plus the number of protons. (T - F)

4. The proton has a negative charge and orbits around the nucleus. (T - F)

5. A conductor is a material which allows current to flow through it. (T - F)

6. The flow of current through a circuit is measured in volts. (T - F)

7. Motors, lamps, bells, and heaters are devices used as loads in electrical circuits. (T - F)

8. A supply provides the source of voltage and current for circuit operation. (T - F)

9. Voltage provides the "pressure" needed to force electrons through a circuit. (T - F)

10. Electrons always flow from negative to positive in an electrical circuit. (T - F)

11. Voltage is measured in the basic unit ______________________________.

12. The ampere is the basic unit of measurement for ________________.

13. To qualify as a complete electrical circuit, a supply, conductor, a load and a ______________________________ are required.

14. Using the information given below, determine the number of neutrons present in the gold atom. _____________ neutrons.

GOLD 197
$_{79}\mathrm{Au}$

15. Electricity travels through a wire, or circuit at about the speed of _______________________.

A. sound b. wind c. water d. light.

LII-U6-6

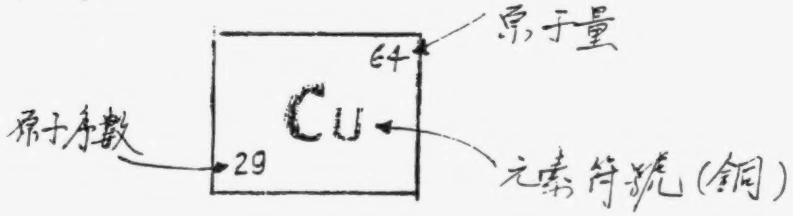
電氣本質（NATURE OF ELECTRICITY）

技術語彙

安培（AMPERE）：計量电流的基本單元。　　縮写為：A

原子（ATOM）：元素能被分割成依然保有其原本特性的最小粒子。例如
一个 penny 可分割出銅原子（an atom of copper），原子擁
有三种顆粒：質子（protons），电子（electrons）及中子（neutron

原子序數（ATOMIC NUMBER）：元素在週期表中表示出兩种數目中之
數小的數目即為原子序數，代表該原子的原子核中質子的
數目。例如



原子量（ATOMIC WEIGHT）：元素在週期表中表示出的另一較大的數目
表示原子的原子核的總重量。

完整电路（COMPLETE CIRCUIT）：一個電氣路线其至少包括：电源
（supply），电負荷（load），电控制（control）及導体（condu
ctor）。所有具电氣功能的电路均包含這四种組件。

導体（導綫）（conductor）：能讓电流自由通流的物体，如銅、鋁
及銀等均是。

电控制器（control）：完整电路的一部份，其能指揮电流在电
中通行（開）（turns on）、停止，関（turns off）的動作。

电流（current）：电子在电氣路线上有規律地流通。縮写為"

LII-UE-7

电子(ELECTRON):在原子中帶負电的粒子.电子位於原子外的"殼層(shell)及環繞原子核運轉.

电子殼層(ELECTRON SHELL):电子在原子中的位置.每層电子組成殼層.每一殼層有一定的电子最大容納數。

电負荷(电載)(LOAD):在电路設計中用來利用產生功能的配件物品,如馬達,燈,揚聲器,發熱器(管)等.

中子(NEUTRON):在原子核中不帶电(非正电亦非負电)的粒子.

原子核(NUCLEUS):原子的中心主体,其包有質子及中子,構成原子的"核心"(core),並是原子質量的絕大部份。

質子(PROTON):在原子核中帶正电的粒子.

供电(电源)(SUPPLY):能提供必須的电壓及电流使电路能夠運作的裝配.典型的裝配為:电池(batteries)發电機(generators)及太陽电池(solar cells).這种能提供的設備通常稱作电源(source)

價电殼層(VALENCE SHELL):原子最外層的电子殼層,也比作"掛鈎"(hook),是电子殼層中最具化学性及电学性行為的殼層。基本上決定該物質的电氣特性是在此殼層的價电子(valence electrons).

伏特(VOLT):計量电壓的基本單位,縮寫為"V"

电壓(VOLTAGE):使电子通流於电路的"壓力"或"推動力"。电壓的另外表示如:电子移位能量及位差。縮寫為"E"

LII-116-8

字彙一 填字遊戲

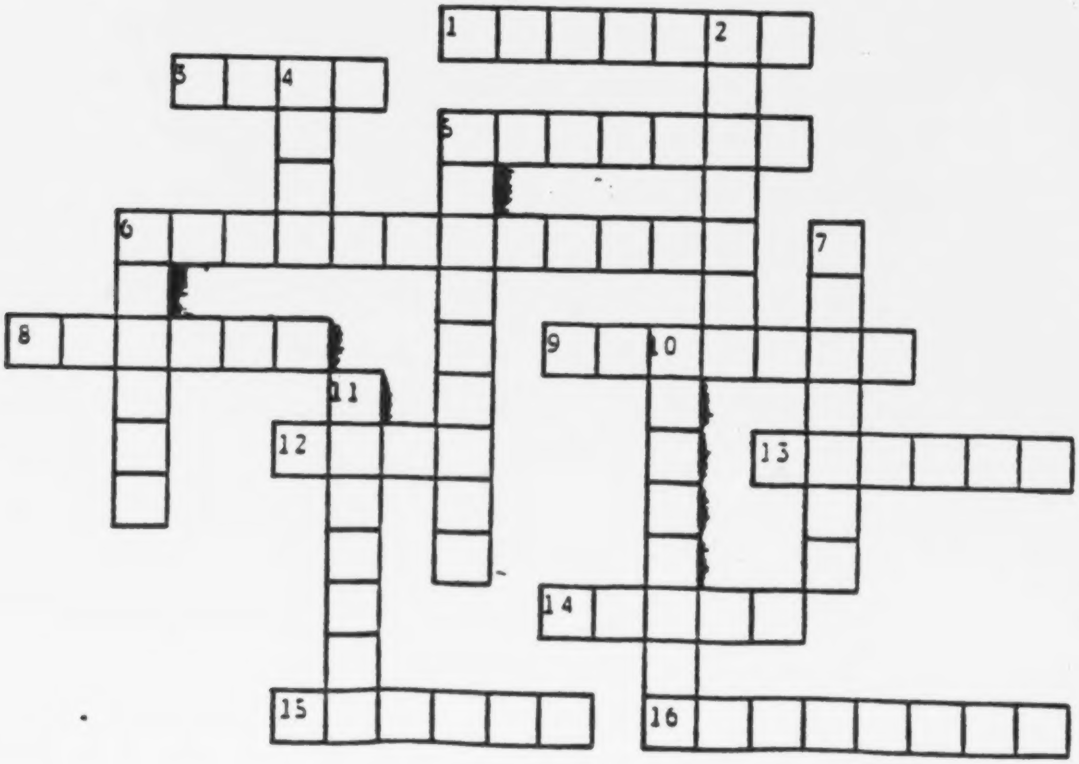
橫向

1. 最外層电子殼層
3. 被設计在电路中運作的裝置
5. 电子在电路中有規律地流通。
8. 提供电压及电流,使电路運作的裝置。
9. 原子的核心。
12. 电压基本单元。
13. 原子的原子核中帶正电的粒子。
14. 在原子内放置电子的地方。
15. 表示原子質量大小謂之 atomic ______.
16. 原子中帶負电的粒子。

縱向

2. 完整电路中一部份。以指揮电流通流路线。
4. 元素能被分割成的最小顆粒。
6. 电流通流的基本单元。
7. 原子核心中的中性粒子。
10. 一個电气路线包含供电,电負荷,电控制及導体。
11. 电子移位力量。

VOCABULARY - CROSSWORD PUZZLE



LII-U6-9

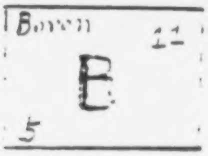
了解測驗 (QUEST ACTIVITY)

第六單元 (UNIT 6)

1. 原子中環繞原子核的电子軌道稱之 ________。 1.
2. 原子核包含 A) ________ 及 B) ________。 2.A
2.B.
3. 表示原子中質子數目的是 atomic ________。 3.
4. 一个中性原子是包含相等數目的 A) ______ 及 B) ____。 4A
4B.
5. 原子内最外層电子殼層稱為 ________。 5.
6. 电子移位力量通常稱作 A) ________。其基本計量單元是 B) ________。 6A
6B
7. 电子有規律地在电路中流通稱之 A) ________ 7A.
其基本計量單元是 B) ________。 7B.
8. 元素可以分割成最小而依然保有基本特性的顆粒稱為 ________。 8.
9. 帶不同电荷的物体会 A) ________ 9.A.
帶相同电荷的物体会 B) ________ 9.B.
10. 帶正电的粒子会吸引帶 A) ______ 电荷者或 B ______ 粒子。 10A.
10.B.
11. 列出原子的三種基本粒子及其帶電荷性質.

粒子 (particle)	电荷 (charge)

12. 劃出硼原子 (Boron atom) 之結構

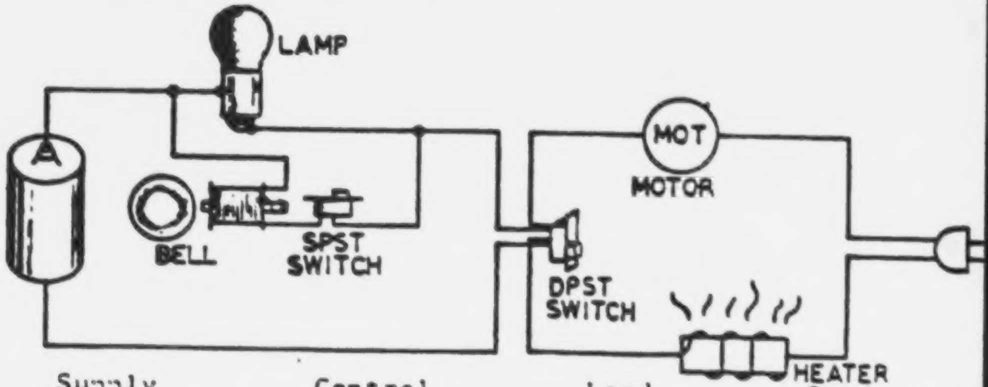


13. 劃出銅原子(copper atom)之结構

copper 64
Cu
29

14. 畫一簡單的完整电路圖，標示出四種在电路中具特性的裝置.

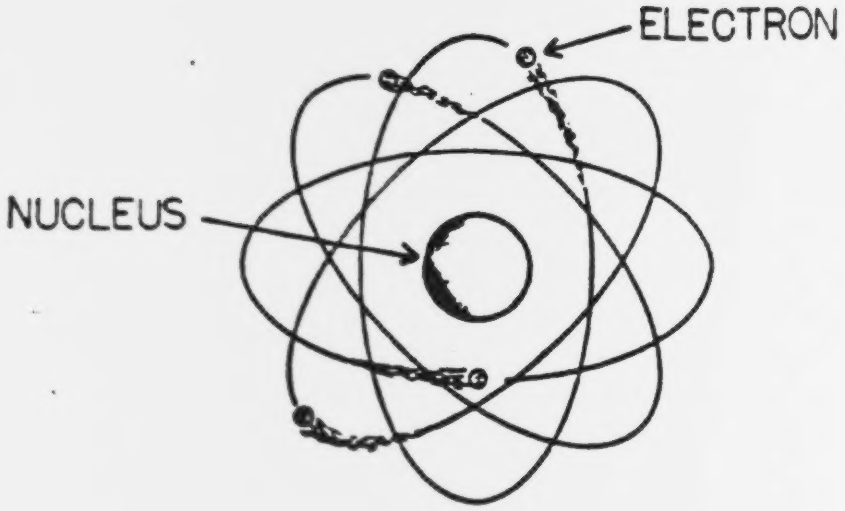
15. 標示出下圖中何物為电源，电控制，电負荷及導体.


LAMP
A
BELL
SPST SWITCH
MOT
MOTOR
DPST SWITCH
HEATER

Supply Devices
Control Devices
Load Devices
Conductor Element

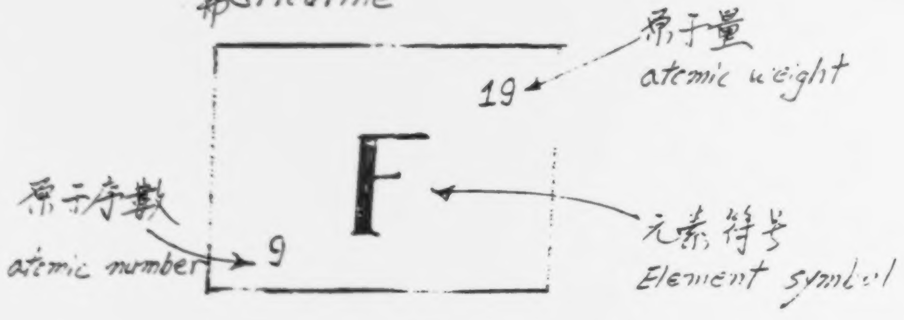
LII-UG-11, -12

原子结構


ELECTRON
NUCLEUS

由週期表(PERIODIC TABLE)中得之資料

氟 Fleurine


原子量
atomic weight
19
F
原子序數
atomic number
9
元素符号
Element symbol

畫原子結構

要畫出原子结構你必須首先要知道該原子中包含多少个質子,电子及中子。原子序數提供了一部份數值,它表示出原子中质子的數量在纯质的状態下,原子擁有相同數目的质子及电子,所以原子序數正確地指示出电子或质子的數量。由原子量數值減原子序數值則得到中子的數量。

由上圖氟原子資料,你应該能夠列出质子,电子及中子在該原子的數量

质子數 — 9
电子數 — 9
中子數 — 10

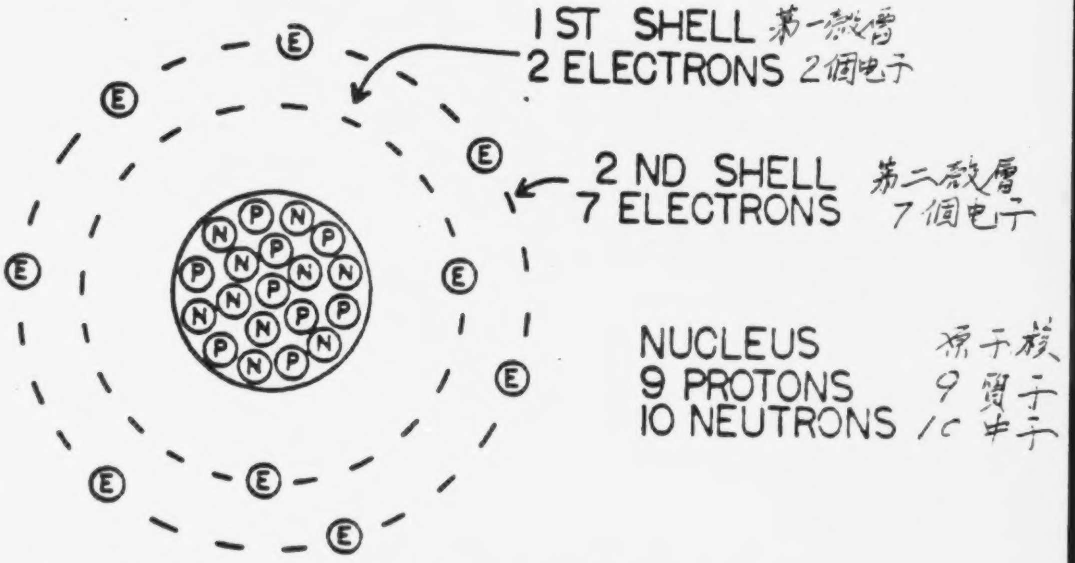
一旦以上資料被決定，則一簡單的原子結構圖就可以畫出。

1). 在圖中心位置畫出原子核內的質子數及中子數。

2). 电子置於电子殼層並形成環繞原子核的电子軌道，每殼層有一定的电子最大容納數。

第一殼層	第二殼層	第三殼層	第四殼層
2個电子	8個电子	18個电子	32個电子

這些电子粒必須依順序地（由第一殼層起）置於殼層中，先置至最大容納數才置次殼層.

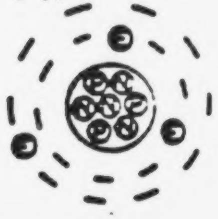

1ST SHELL 第一殼層
2 ELECTRONS 2個电子
2ND SHELL 第二殼層
7 ELECTRONS 7個电子
NUCLEUS 原子核
9 PROTONS 9質子
10 NEUTRONS 10中子
E
P
N

现在你了解此系统，用你所新得的知識畫出鋰（Lithium）原子

$_{3}\mathrm{Li}^{7}$

Protons -
質子
Electrons -
电子
Neutrons -
中子

答案：



LII-UG-6

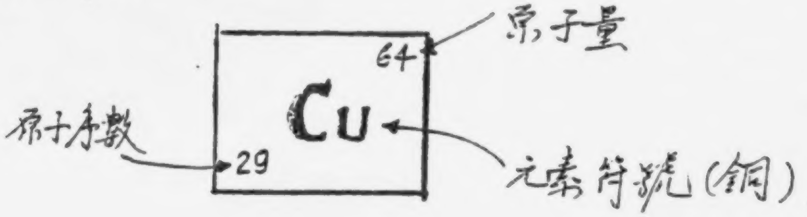
電氣本質 (NATURE OF ELECTRICITY)

技術語彙

安培(AMPERE)：計量电流的基本單元.　　　縮寫為：A

原子(ATOM)：元素能被分割成依然保有其原本特性的最小粒子。例如由一个 penny 可分割出銅原子 (an atom of copper)。原子擁有三种顆粒：質子 (protons), 电子 (electrons) 及中子 (neutrons).

原子序數 (ATOMIC NUMBER)：元素在週期表中表示出兩种數目中之一。數小的數目即為原子序數，代表該原子的原子核中質子的數目. 例如



原子量 (ATOMIC WEIGHT)：元素在週期表中表示出的另一較大的數目. 表示原子的原子核的總重量.

完整电路 (COMPLETE CIRCUIT)：一個電氣路线其至少包括：电源 (supply). 电負荷 (load), 电控制 (control) 及導体 (conductor). 所有具电気功能的电路均包含這四种組件.

導体(導線)(conductor)：能讓电流自由通流的物体，如銅、鋁及銀等均是。

电控制器 (control)：完整电路的一部份，其能指揮电流在电路中通行(開)(turns on)、停止，関(turns off)的動作。

电流 (current)：电子在电気路线上有規律地流通。縮寫為"I"

LII-UE-7

电子(ELECTRON)：在原子中帶負电的粒子，电子位於原子外的"殼層"(shell)及環繞原子核運轉.

电子殼層(ELECTRON SHELL)：电子在原子中的位置，每層电子組成殼層，每一殼層有一定的电子最大容納數。

电負荷(电載)(LOAD)：在电路設計中用來利用發生功能的配件物品，如馬達，燈，揚聲器，發熱器(管)等。

中子(NEUTRON)：在原子核中不帶电(非正电亦非負电)的粒子。

原子核(NUCLEUS)：原子的中心主体，其包有質子及中子，構成原子的"核心"(core)，並是原子質量的绝大部份。

質子(PROTON)：在原子核中帶正电的粒子.

供电(电源)(SUPPLY)：能提供必須的电压及电流使电路能夠運作的装配，典型的装配為：电池(batteries)發电机(generators)及太陽电池(solar cells)，這种能提供的設備通常称作电源(source).

價电殼層(VALENCE SHELL)：原子最外層的电子殼層，也叫作"掛鈎"(hook)，是电子殼層中最具化學性及电氣性行為的殼層。基本上決定該物質的电氣特性是在此殼層的價电子(valence electrons).

伏特(VOLT)：計量电压的基本單元，縮寫為"V".

电压(VOLTAGE)-使电子通流於电路的电氣力量或压力。电压的另外表示如：电子的位力量及位差。縮寫為"E".

字彙一填字遊戲

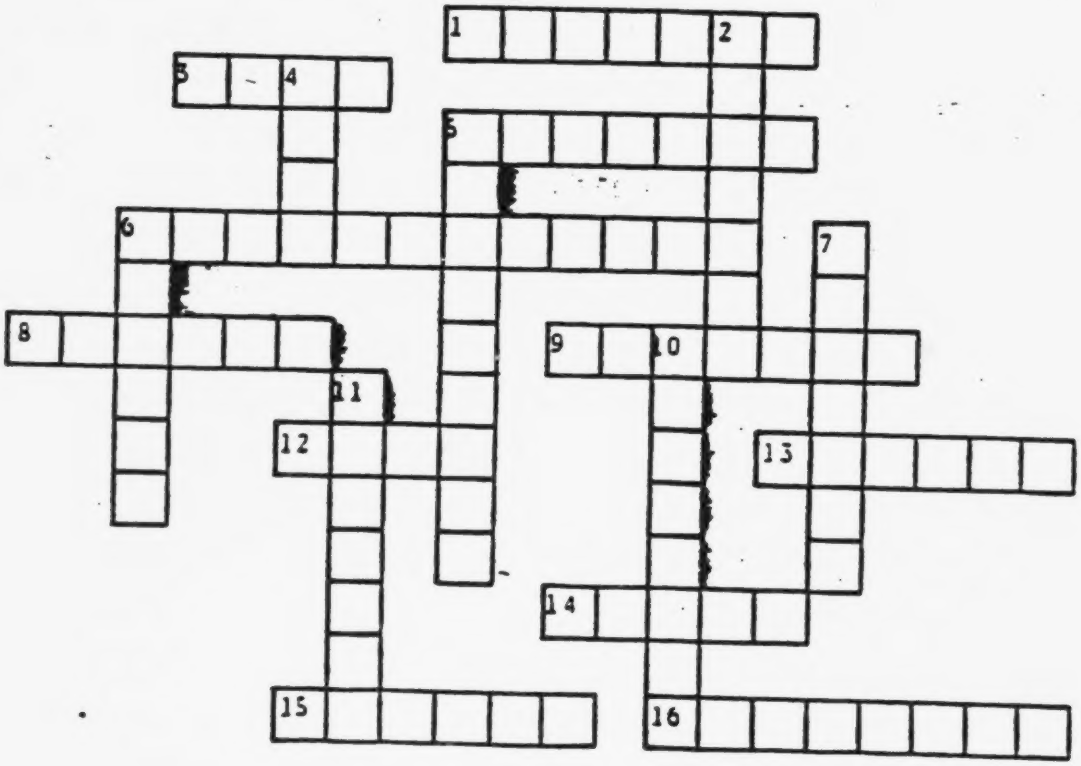
横向

1. 最外層电子殼層
3. 被設計在电路中運作的裝置
5. 电子在电路中有規律地流通.
8. 提供电压及电流,使电路運作的裝置。
9. 原子的核心.
12. 电压基本單元.
13. 原子的原子核中帶正电的粒子.
14. 在原子内放置电子的地方.
15. 表示原子質量大小謂之 atomic ______.
16. 原子中帶負电的粒子.

縱向

2. 完整电路中一部份。以指揮电流通流路线。
4. 元素能被分割成的最小顆粒。
6. 电流通流的基本單元.
7. 原子核心中的中性粒子.
10. 一個电気路线包含供电,电負荷,电控制及導体,
11. 电子移位力量.

VOCABULARY - CROSSWORD PUZZLE



LII-U6-9

了解測驗 (QUEST ACTIVITY)

第六單元 (UNIT 6)

1. 原子中環绕原子核的电子軌道稱之 ______. 1.

2. 原子核包含 A) ______ 及 B) ______。 2.A

2.B

3. 表示原子中質子數目的是 atomic ______， 3.

4. 一个中性原子是包含相等數目的 A) ______ 及 B) ______。 4A

4B.

5. 原子内最外層电子殼層稱為 ______。 5.

6. 电子移位力量通常稱作 A) ______。其基本計量 6A
單元是 B) ______。 6B

7. 电子有規律地在电路中流通稱之 A) ______ 7A.
其基本計量單元是 B) ______。 7B.

8. 元素可以分割成最小而依然保有基本特性的微粒 8.
稱為 ______。

9. 帶不同电荷的物体会 A) ______ 9A.
帶相同电荷的物体会 B) ______ 9B.

10. 帶正电的粒子会吸引帶 A) ______ 电荷者或 B ______ 粒子。 10A.

10B.

11. 列出三種原子的基本粒子及其帶电荷性質.

粒子 (particle)	电荷 (charge)

12. 劃出硼原子 (Boron atom) 之結構

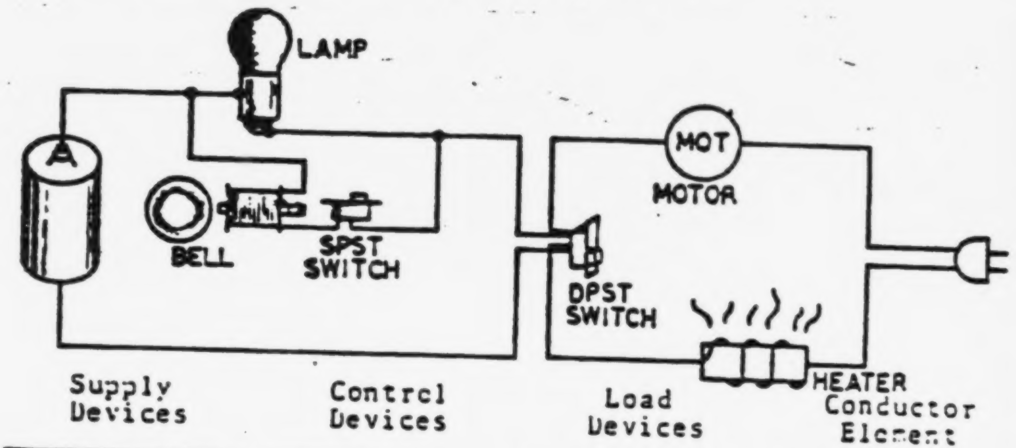
Boron 11
B
5

13. 劃出銅原子(copper atom)之結構

Copper 64
Cu
29

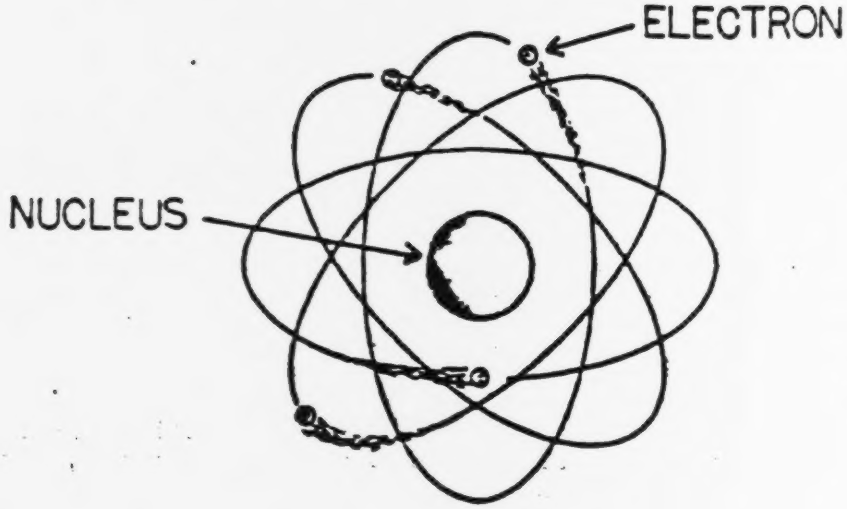
14. 畫一簡單的完整电路圖,標示出四种在电路中具特性的裝置.

15. 標示出下圖中何物為电源,电控制;电負荷及導体.


LAMP
A
BELL
SPST SWITCH
MOT
MOTOR
DPST SWITCH
HEATER

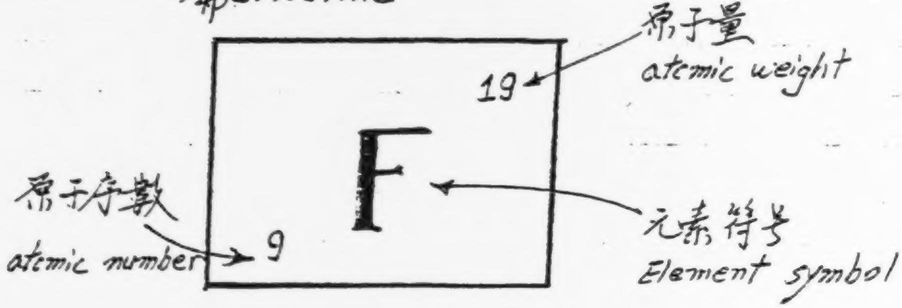
Supply Devices	Control Devices	Load Devices	Conductor Element

原子結構


ELECTRON
NUCLEUS

由週期表(PERIODIC TABLE)中得之資料

氟 Fluorine


原子量
atomic weight
19
F
原子序數
atomic number
9
元素符号
Element symbol

畫原子結構

要畫出原子結構你必須首先要知道該原子中包含多少个質子，电子及中子。原子序數提供了一部份數值，它表示出原子中质子的數量。在純質的狀態下，原子擁有相同數目的质子及电子，所以原子序數正確地指示出电子或质子的數量。由原子量數值減原子序數數值則得到中子的數量。

由上圖氟原子資料，你应該能夠列出质子，电子及中子在該原子的數量

质子數 — 9
电子數 — 9
中子數 — 10

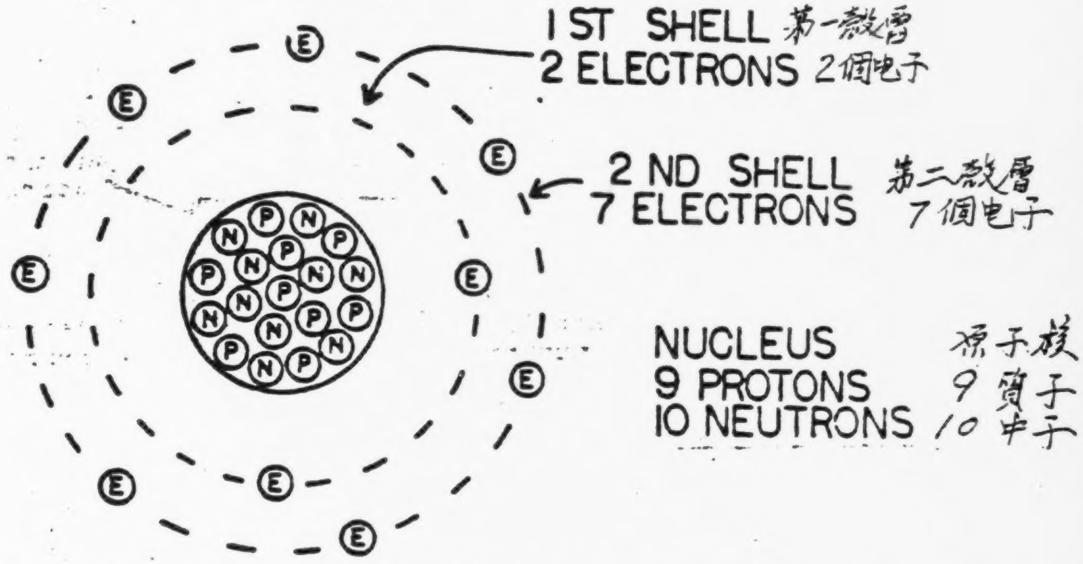
一旦以上資料被決定，則一簡單的原子結構圖就可以畫出。

1). 在圖中心位置畫出原子核内的质子數及中子數。

2). 电子置於电子殼層並形成環繞原子核的电子軌道，每殼層有一定的电子最大容纳數。

第一殼層	第二殼層	第三殼層	第四殼層
2個电子	8個电子	18個电子	32個电子

這些电子粒必须依顺序地(由第一殼層起)置於殼層中，先置至最大容纳數才置次殼層.

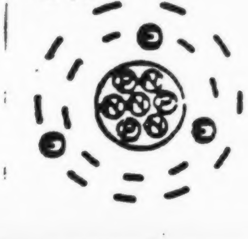

1 ST SHELL 第一殼層
2 ELECTRONS 2個电子
2 ND SHELL 第二殼層
7 ELECTRONS 7個电子
NUCLEUS 原子核
9 PROTONS 9 質子
10 NEUTRONS 10 中子
E
P
N

现在你了解此系统了，用你新得的知識畫出鋰(Lithium)原子結

$_{3}\mathrm{Li}^{7}$

Protons -
质子
Electrons -
电子
Neutrons -
中子

答案：



ELECTRONIC C CULUM

VOCATIONAL TRAINING LE . PLAN # VII Conductors and Insulato

Teaching Materials Source ______________________________

Chapter ______________, pages ______________________

Lab Manual pages ________________

Additional Instructor Materials ______________________________

Main concepts student will learn:

The student will be able to:

1. differentiate between the characteristics of conductors, insulators, or semiconductors, and identify specific examples of materials that occupy each category.
2. describe the fundamental purpose and importance of conductors and insulators in relationship to an electrical or electronic circuit.
3. physically demonstrate an ability to properly strip both solid or stranded wire, and to verbally list the correct procedures to employ in order to obtain the aforementioned results.

Length of Lesson

1 week

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

Technical Vocabulary

see Technical Glossary

Related General Vocabulary

As needed from the definions and Reading Material

Materials and Notes

Objective #3 is met by completion of the Lab projects completed as a part of Unit III Tool Use.

Students are working on conductors and insulators while they are also working on projects they started in Unit III.

Teaching Activity

Explain some related factors to be considered when selecting or preparing conductors. Discuss such considerations as types of wire, braids, multiple-wire cables, wire sizes, wire harnesses, lacing, adn wire color code.

Hopefully, in this unit a variety of laboratory activities will assist students in developing or reviewing some basic mechanical and electrical skills. Simple exercises on wire indentification, techniques of wire stripping, or methods of fabricating wire harnesses can really help introduce students to many basic assembly procedures.

Wire stripping of stranded wire is taken for granted by many instructors, however, the correct technique is sometimes difficult for students to acquire. When teaching this skill make an effort to explain what happens electrically and mechanically when strands are broken during the stripping process.

Do not overlook emphasizing insulators as a major subject topic. Two main discussion points can be that insulators are rated by the amount of voltage required to break down their insulating properties, and that insulators are selected according to the surroundings in which they will

Name: ____________________

Date: ____________________

CONDUCTORS AND INSULATORS

Period: ____________________

TECHNICAL GLOSSARY

CHAIN REACTION:	A series of events which occur in rapid order, due to some input or "starting" action. The toppling of a line of dominoes, or the flow of electrons through a wire are common examples of chain reactions.
CHEMICAL STABILITY:	An indiction of an atom's tendency to mix or react with other atoms. Generally, an atom with a full valence shell (8 outer electrons) will be very stable and thus not react chemically or electrically. An atom with only one valence electron, on the other hand is very unstable, and thus very chemically or electrically active.
CONDUCTOR:	A material through which an electrical current will easily flow. Conductors contain many free electrons which contribute to current flow. The best conductors contain only one valence electron and are metals.
DIELECTRIC:	A term used to describe an insulator. Thus, a dielectric material is also an insulating material.
ELECTRICAL IMPULSE:	The chain reaction caused when an electron is forced into a circuit, simultaneously causing another electron to leave the circuit. This electrical impulse, or chain reaction, continues throughout the circuit at the speed of light, as long as pressure is applied.
FREE ELECTRON:	Electrons which are removed from the valence shell of their atom, usually by electrical pressure, and are free to move through a wire or circuit. Free electrons moving in the same direction through a conducter produce an electric current.
INSULATOR:	A material which does not allow current flow. Insulators contain few free electrons and therefore do not provide a easy path for current flow. The best insulators contain eight valence electrons and are compounds such as plastic glass, etc.
SEMICONDUCTORS:	A material that can act as either an insulator or conductor depending upon its temperature or chemical purity. Semiconductors contain four valence electrons and the most common examples are silicon and germanium.
SPEED OF LIGHT:	The speed at which light travels through the atmosphere. This speed has been established as 300,000,000 meters per second. Recall, an electrical impulse will travel through a conductor at the speed of light.
STRIPPING:	The process of removing the insulating material (plastic, cloth, enamel) from a wire or conductor.

SCORE:

GRADE:

Name: /

Date:

Period:

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Develop a short definition, using your own words, for the following terms.

1. CONDUCTOR:

2. INSULATOR:

3. SEMICONDUCTOR:

4. FREE ELECTRON:

For the following vocabulary terms, include a sketch to enhance and clarify your "word" definition.

5. CHAIN REACTION:

6. ELECTRICAL IMPULSE:

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 8"

Utilizing a simple experimental technique (continuity tester, ohmmeter, simple series lamp circuit) or a research procedure (test book, and/or chemical handbook) classify the following materials as either conductors, insulators, or semiconductors. Write the results of your research activity in the box provided.

1. copper
2. plastic
3. cloth
4. steel
5. enamel
6. gold
7. silicon
8. glass
9. ceramic
10. silver
11. germanium
12. aluminum
13. mica
14. paper
15. carbon
16. wood
17. air
18. lead
19. paraffin wax
20. tin

Name: ____________________

Date: ____________________

Period: ____________________

21. The purpose of a conductor is:

22. The purpose of an insulator is:

23. List the three "best" conductors for electrical current flow.

23A.

23B.

23C.

24. The wire most commonly used for electrical conductors is made of soft, __________.

24.

25. Conductors contain many __________ electrons.

25.

26. The most common semiconductor materials are silicon and __________.

26.

27. Wire strippers are designed to remove the __________ from wires.

27.

28. List one desirable feature of solid wire.

29. Name one advantage stranded wire has over solid wire.

30. When a power cord uses a heavy gauge wire with thick plastic insulation or asbestos cloth insulation, what does it indicate about the load device?

Name: ______________

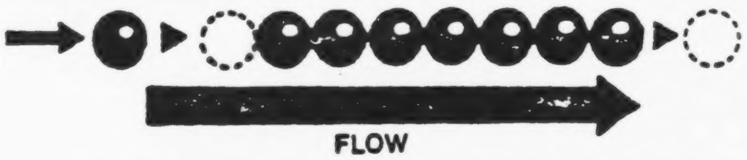
Date: ______________

Period: ______________

INFORMATIONAL HANDOUT

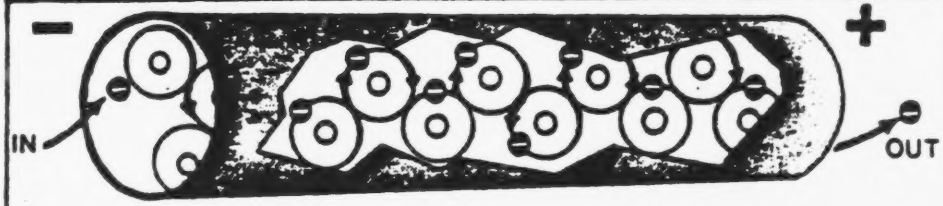
CURRENT FLOW THROUGH A CONDUCTOR

Electrical current flow is caused by an orderly flow of electrons through a circuit or conductor. You will find, that each time an electron enters a wire or conductor, another electron will be forced out of that conductor. This action is similar to the flow of energy through a long row of billard balls as shown below:



When the first ball is struck, the force is transferred from ball to ball until the last ball is forced from the row.

In a conductor, the valence electrons of the copper atoms, in effect become the billard balls. As the source or voltage forces an electron into the wire, that electron will enter a near by valence shell, forcing out the "resident" electron. This now free electron will in turn enter another near-by valence shell, forcing out its "resident" electron. This procedure continues until an electron exits the end of the wire. Although this procedure seems complex, it occurs at a very rapid speed 300,000,000 meters per second, or the speed of light.



The electrical phenomenon pictured above is known as an electrical impulse.

It may seem peculiar, but an individual electron moves rather slowly through a wire - approximately 10.92 millimeters per second (4.28 inches per second) - but, the total effect of an electrical current travels at the speed of light, which is.........

186,000 miles/sec.

2

Name: ____________________

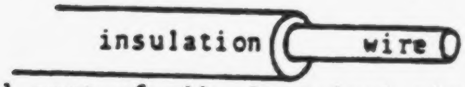
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

WIRE: PURPOSE AND APPLICATION

PURPOSE -

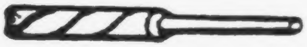


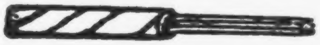
Wire is an essential part of all electrical circuits and you should review below some of the important factors to be considered when selecting or using wire.

A conductor (wire) provides the path or highway for the movement of electrons, and many times wire is covered with insulation to keep the current safely within the wire.

CONDUCTOR + INSULATOR = WIRE
CONDUCTOR - INSULATOR = BARE WIRE

Types of Wire -





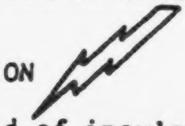
Solid wire is usually made from one thick copper thread. It is easy to handle and to solder, yet, when a lot of physical movement is necessary this kind of wire should not be used. You can purchase this wire in a variety of outside colors and sizes. Components like resistors, capacitors, inductors, and transformers have solid wires (leads) extending from the body of the device so that the component may be connected securely to the circuit.

USAGE EXAMPLE: Solid wire is used to complete electrical circuits in the walls of homes, schools and industries.

Stranded wire is made from a bunch or group of copper threads that have been twisted together to appear like one wire. When flexibility is important this is the type of wire to use. Remember that you must really be careful when stripping this kind of wire or some of the strands will be destroyed causing the wire to be both mechanically weak and not able to handle all of the current flow. Stranded wire is generally tinned with solder before being connected to a circuit point.

USAGE EXAMPLE: Stranded wire is used in cables, appliances, and extension cords.

WIRE INSULATION - PROTECTION

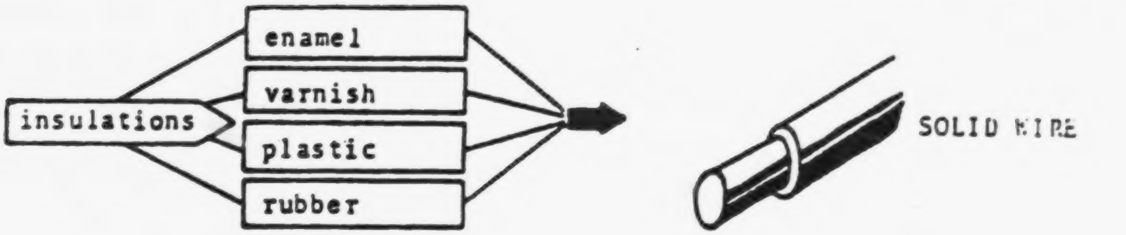


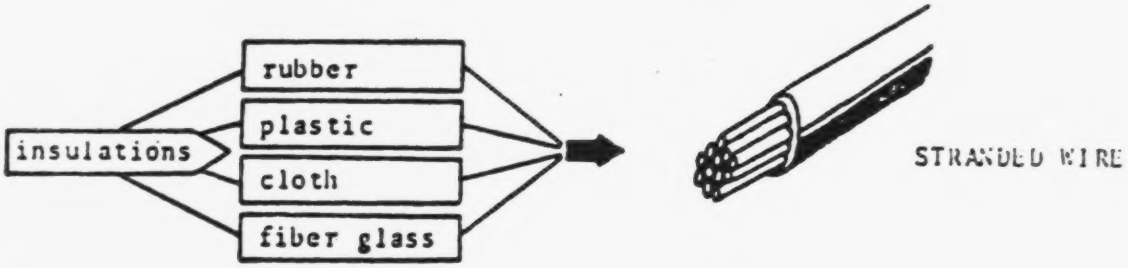
Most wires are covered by some kind of insulating material to prevent short circuits and dangerous accidents! Look at the various types of coverings associated with each kind of wire on the following page.

Name: ____________________

Date: ____________________

Period: ____________________


insulations
enamel
varnish
plastic
rubber
SOLID WIRE

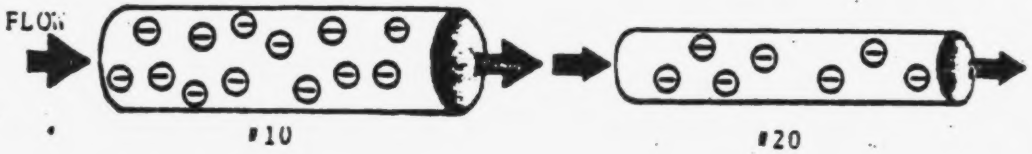

insulations
rubber
plastic
cloth
fiber glass
STRANDED WIRE

WIRE SIZES -

The American Wire Gauge (AWG) number is a system of describing by number, the size or electrical capacity of the wire. The larger the wire number, the smaller the diameter of the wire. Of course, it is important to select the proper size of wire for the job at hand.

NOTE: A wire gauge is a device that can be used to determine the size of wire.

SIZE EXAMPLE: A #20 wire can carry less current than a #10 wire because the #20 is physically smaller in size, hence less current can travel through this wire.



WIRE IN GENERAL

Most wire is now made from copper because it is such a good conductor of electricity and can be purchased at a fair price. Silver is rated as a better conductor, however, it is far more expensive which means increased cost, thus, it is seldom used by manufacturers.

CONTINUITY TESTING

Lab Sheet #2

OBJECTIVES

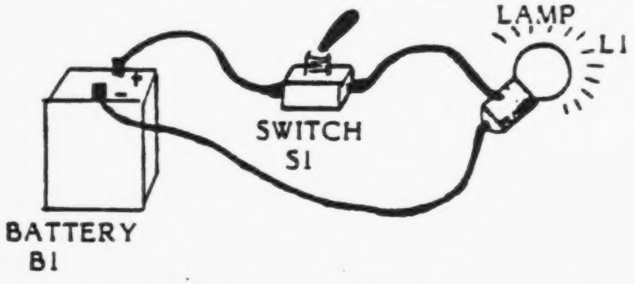
To learn what an "OPEN" circuit is
To learn what a "SHORTED" circuit is
To learn how to test a circuit for either CONTINUITY or an OPEN
To learn how to troubleshoot a simple conductive circuit
To learn how to check a fuse, lamp, and switches with the ohmmeter

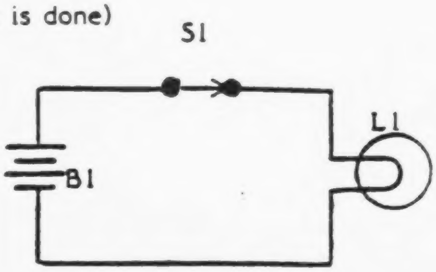
INTRODUCTION

An electrical circuit is an unbroken path for electrons to move from one point to another. The flowing electrons in the circuit are referred to as the CURRENT in the circuit. Circuits are made of CONDUCTORS, like wires and metal strips. Circuits can have SWITCHES in them to stop the electrons flowing. Switches stop the current by opening the conductive path. When a switch is turned "off", it is like disconnecting the conductor. When a switch is "on", it is like connecting the conductor and completing the circuit so the current can flow. A circuit does not have to have a switch, but it is nice to have if you want to turn a light "off"!

Shown below is a complete circuit consisting of 4 parts:

1. BATTERY (The source of power)
2. WIRES (The conductors)
3. SWITCH (It opens and closes the circuit)
4. LAMP (The load where the work is done)





A circuit has CONTINUITY when current can flow without interruption, such as when the switch is "on". If there is a broken wire, the circuit does not have continuity and we say the circuit is OPEN. An OHMMETER is used to test if a circuit has either CONTINUITY or an OPEN. In PROJECT 1, you will use an ohmmeter to test simple circuits for either CONTINUITY or an OPEN.

MATERIALS

VTVM or VOM
DMM
Continuity Board

PROJECT 1: Testing Circuits for Either Continuity or an Open.

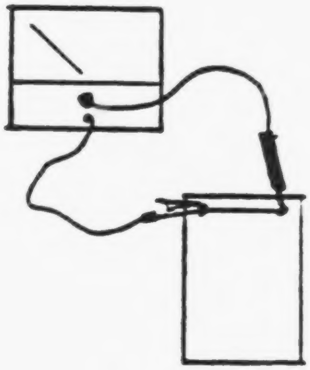
INTRODUCTION

Imagine that the Continuity Board is one of many printed circuit boards out of an expensive piece of electronic equipment: a Zorchatron, Mark VI. You and your lab partner are the technicians who now must test this board. The head troubleshooter narrowed the problem down to this particular board. Unfortunately, before the troubleshooter could check this board, he was electrocuted in the Zorchatron. His demise was not surprising, as he always worked fast, seldom read instructions, and often made "little" mistakes.

Your task now is to test the Continuity Board. You will use the VTVM ohmmeter to test it for open conductors. The conductors on this type of a printed circuit board are metal strips on the bottom side of the board. There is a terminal at either end of each conductor. We will call each conductor "circuit A", "circuit B", etc. Also, each terminal is numbered.

INSTRUCTIONS

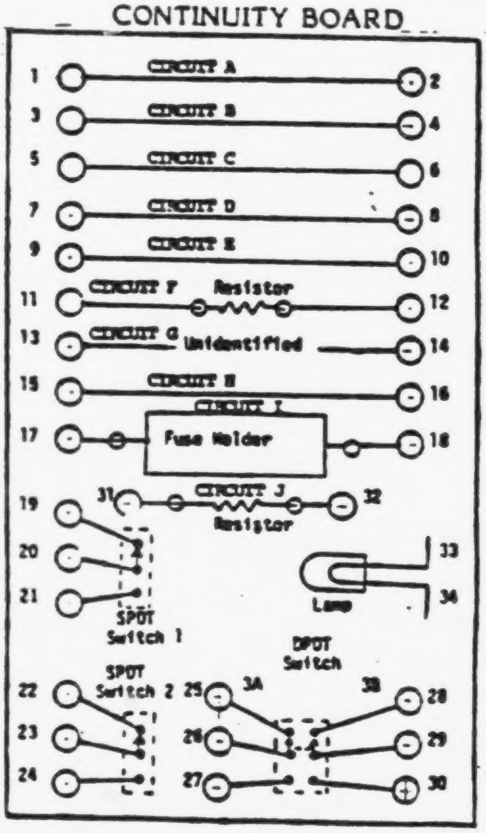
1. Calibrate the VTVM on the Rx1 scale.
2. Test Circuit A for continuity as shown:



Does Circuit A have CONTINUITY or is it OPEN?

(It should measure 0 ohms. Therefore, the circuit is not OPEN and does have CONTINUITY. The current can flow without interruption from terminal 1 to terminal 2. Circuit A is a good conductor.)

CONTINUITY BOARD


1
CIRCUIT A
2
3
CIRCUIT B
4
5
CIRCUIT C
6
7
CIRCUIT D
8
9
CIRCUIT E
10
11
CIRCUIT F
Resistor
12
13
CIRCUIT G
Unidentified
14
15
CIRCUIT H
16
CIRCUIT I
17
Fuse Holder
18
19
31
CIRCUIT J
Resistor
32
20
21
SPDT
Switch 1
33
Lamp
34
DPDT
Switch
SPDT
Switch 2
22
23
24
25
26
27
3A
3B
28
29
30

3. Test Circuit B in the same way. NOTE: If you find it measures infinite resistance on the Rx1 scale, set the RANGE selector to Rx1Meg to insure that it is really open. Don't forget to check the VTVM calibration on Rx1Meg range.

(Check one.)

__Circuit B has continuity since it measures 0 ohms. Circuit B is a good conductor.

__Circuit B is open since it measures infinite ohms. Circuit B is not a good conductor.

4. If you found that Circuit B was "open", (on Rx1Meg) you were correct. Now test Circuits C through J. This time watch for circuits that are not open, but have a high resistance in them; if not "open", they will be considered "GOOD CIRCUITS". Record your findings below:

Circuit C (5 - 6) Ohms:________

GOOD / NOT GOOD(OPEN)

Circuit D (7 - 8) Ohms:________

GOOD / NOT GOOD(OPEN)

Circuit E (9 - 10) Ohms:________

GOOD / NOT GOOD(OPEN)

Circuit F (11 - 12) Ohms:________

GOOD / NOT GOOD(OPEN)

Circuit G (13 - 14) Ohms:________

GOOD / NOT GOOD(OPEN)

Circuit H (15 - 16) Ohms:________

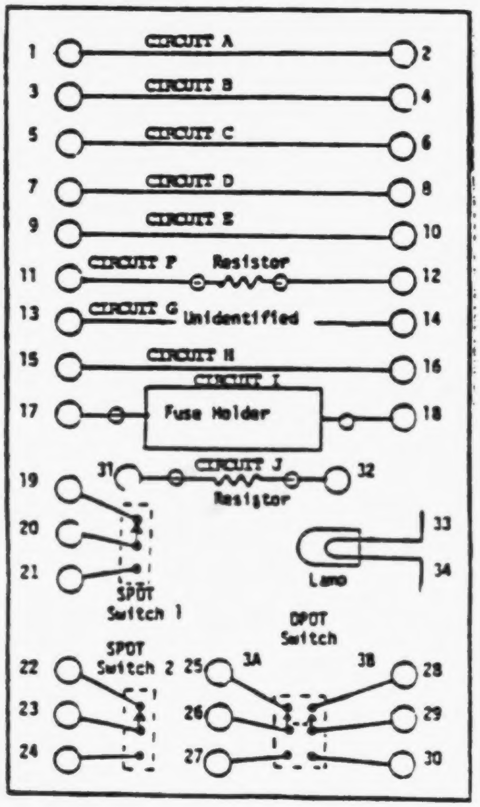
GOOD / NOT GOOD(OPEN)

Circuit I (17 - 18) (Skip this one for now.)

Circuit J (31 - 32) Ohms:________

GOOD / NOT GOOD(OPEN)

CONTINUITY BOARD


1
CIRCUIT A
2
3
CIRCUIT B
4
5
CIRCUIT C
6
7
CIRCUIT D
8
9
CIRCUIT E
10
11
CIRCUIT F
Resistor
12
13
CIRCUIT G
Unidentified
14
15
CIRCUIT H
16
CIRCUIT I
17
Fuse Holder
18
19
31
CIRCUIT J
Resistor
32
20
33
21
34
Lamp
SPDT
Switch 1
DPDT
Switch
SPDT
Switch 2
22
25
3A
3B
28
23
26
29
24
27
30

5. Check how well you did. You should have found these conditions: Circuits C, D, E, and H are 0 ohms (good). Circuit F is 1.5 Megohms (good). Circuits G and J are each 200kohms (good).

6. Circuit I is a fuse holder and fuse. Fuses should have a very low resistance from 0 to less than a 10 ohms if they are good. The purpose of a fuse is to open the circuit if there is too much current flow for safety. Once it opens (that is, it "blows"), it must be replaced. Now test the fuse in circuit I to determine if it is good (low ohms), or "blown" (open). NOTE: It is also possible that it is missing from the holder! If so, get one from the instructor.

(circle one) The fuse in Circuit I is: good./ blown./ missing.

7. Locate the Lamp. The electrical terminals are on the lamp base. They are numbered 33 and 34 on the drawing of the Continuity Board. If a lamp is good, it should have approximately 30 to 200 ohms resistance. When a lamp "burns out", the filament opens. Test the lamp with the VTVM ohmmeter to see if it is good.

(circle one) The lamp is: good./ open./ missing.

8. How have you done so far?

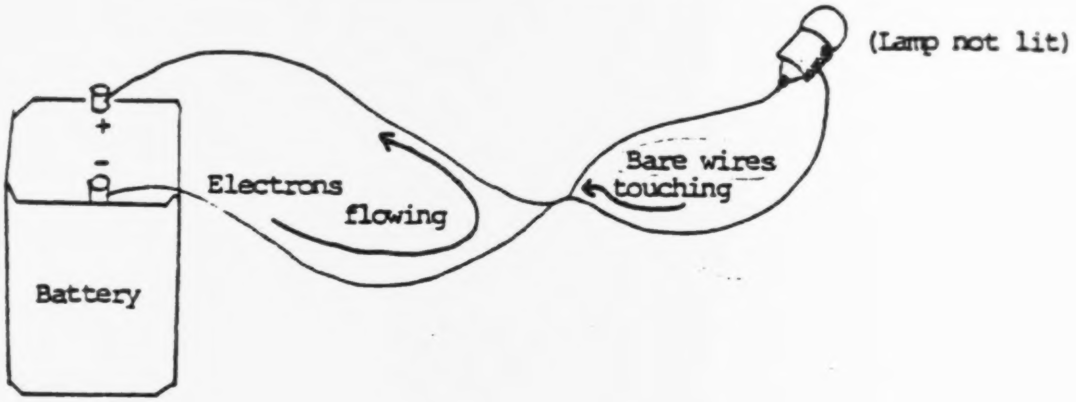
(circle one.) Fantastic!/ So-so./ Not a disaster yet, but close to it.

PROJECT 2: Testing for "SHORTS".

INTRODUCTION

A "SHORT" is an unwanted path for current. You might say it is like a "short-cut" around where we want the current to go. On the Continuity Board there are individual circuits. If you check the drawing of the board you will see that the circuits are not electrically connected. Guess what! They may be connected by a "SHORT" which is not shown on the schematic. Your task is to find the short using the VTVM ohmmeter. Study the drawing below and see how a short can prevent the lamp from lighting, cause much current to flow (possibly causing a fire), and draining the battery.

A "SHORT" circuit is shown below. No electrons are flowing through the lamp. All electrons go through the wires because there is no resistance in this path.



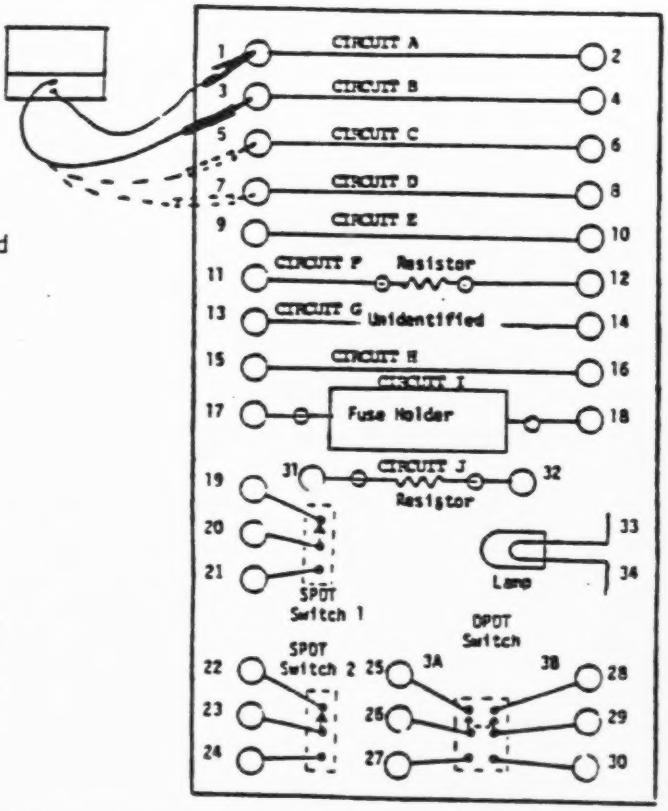
INSTRUCTIONS

1. Use the ohmmeter to check circuits A through I for any shorts to unwanted points. Here is how to do it:

a. Set the VTVM to Rx1Meg. (This is the last time we will be reminding you to CALIBRATE the VTVM when you change ranges.)

b. Put the VTVM "common" test lead (the one with the alligator clip) on CIRCUIT A, either terminal 1 or 2.

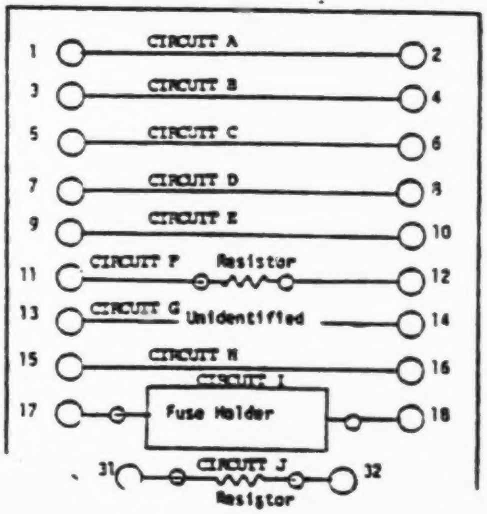
c. Touch the other test lead (probe) to each of the other circuits, B through J (either end terminal). As shown on the schematic, there are no connections between circuits. Therefore, you should measure infinite ohms on each point that you touch with the probe. If you measure less than infinite, there is a SHORT. It could be a LOW RESISTANCE SHORT (0 to a few hundred ohms), or it could be a HIGH RESISTANCE SHORT (many Kohms). In either case, it is an unwanted path for current flow which is not shown on the schematic drawing of the board.


CIRCUIT A
CIRCUIT B
CIRCUIT C
CIRCUIT D
CIRCUIT E
CIRCUIT F
Resistor
CIRCUIT G
Unidentified
CIRCUIT H
CIRCUIT I
Fuse Holder
CIRCUIT J
Resistor
SPDT Switch 1
Lamp
DPDT Switch
SPDT Switch 2
3A
3B
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34

d. After checking circuit A, change the "common" test lead to circuit B. Touch the probe to each of the other circuits, C through J.

e. Repeat this procedure until you have checked all circuits A through J.

f. On the drawing below, mark a pencil line between the circuits which are shorted to each other. (See page 10 for the correct response.)


CIRCUIT A
CIRCUIT B
CIRCUIT C
CIRCUIT D
CIRCUIT E
CIRCUIT F
Resistor
CIRCUIT G
Unidentified
CIRCUIT H
CIRCUIT I
Fuse Holder
CIRCUIT J
Resistor
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
31
32

PROJECT 3: Testing Switches

INTRODUCTION

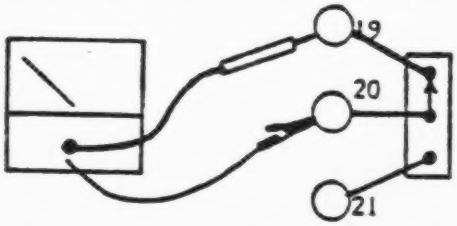
A switch OPENS or CLOSES the circuit when you want it to START or STOP current flow. In your text you learned about several types of switches, such as the SPDT and DPDT. If you don't yet understand these terms, study the text before doing this project.

On the Continuity Board are mounted two SPDT switches and one DPDT switch. You will use the ohmmeter to determine which terminals are open and closed when the switch is "on" or "off".

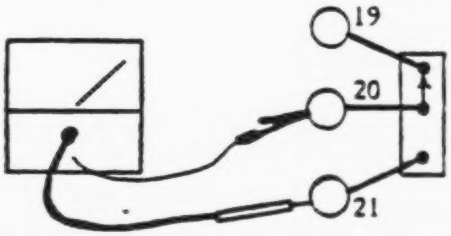
INSTRUCTIONS

1. Locate Switch #1, a SPDT type of a switch. Connect one test lead of the ohmmeter to terminal #20. Touch the other test lead to terminal #19. Move the lever of the switch one way or the other until you have 0 ohms indicated on the ohmmeter. These two terminals of the SPDT switch are "on" now.

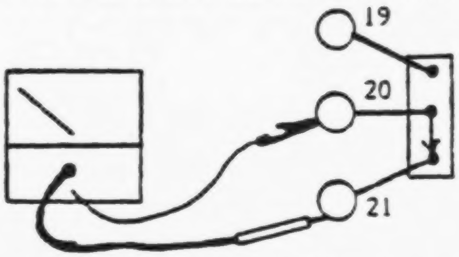
NOTE: The switch lever may be in the opposite position to the electrical pole inside the switch.



2. Remove the test lead from terminal #19 and touch it to terminal #21. Do not move the switch lever. You should read infinite ohms on the ohmmeter. Terminals #20 and #21 are "off" (open), while terminals #20 and #19 are "on" (closed).



3. Leave the test leads on #20 and #21. Move the switch lever to the opposite position that it was during step 2. The ohmmeter should measure 0 ohms now. Move the test lead from #21 to #19 and notice that these two terminals now are open (infinite ohms).

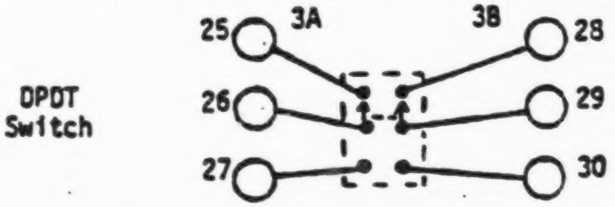


4. Experiment with this switch and the ohmmeter until you get a good understanding of how it is operating. Don't forget that a SPDT switch is really two switches with one common "pole" between them.

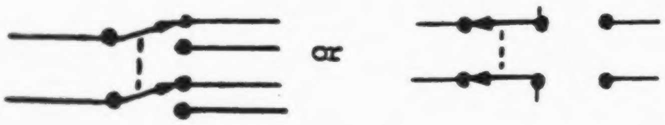
5. Test the operation of Switch #2, another SPDT.

Is Switch 2 operating normally? YES/NO

6. Test the DPDT switch. It is really two SPDT switches in one case and with only one lever. One SPDT switch is designated 3A and the other is 3B.



Each SPDT part of the DPDT switch is electrically isolated from the other SPDT part. They are only MECHANICALLY connected. This mechanical connection is indicated on the drawing by a dotted line. In electronics, it is common practice to indicate mechanical connection of moving parts by a dotted line.



Is Switch 3A operating normally? YES/NO

Is Switch 3B operating normally? YES/NO

PROJECT 4: Using the DMM to Check for Continuity, Opens, and Shorts

INTRODUCTION

You have learned to use the VTVM to check for CONTINUITY, OPENS, and SHORTS. You have also learned to check some basic components for proper operation. Now you will learn to do the same thing using the DMM ohmmeter. The procedure is the same; however, you may find it easier with the DMM since it automatically changes ranges.

INSTRUCTIONS

1. Go back to PROJECT 1 and repeat the steps using the DMM instead of the VTVM. Do all projects again using the DMM. Be sure both lab partners have hands-on experience using both the VTVM and DMM. Remember: Do not use both the DMM ohmmeter and VTVM ohmmeter on the same circuit at the same time.

2. If both lab partners have tested all the circuits with both the DMM and VTVM, go to Lab Sheet #3. The next project (PROJECT 5: Self Evaluation) is to be done outside of the scheduled lab period.

PROJECT 5: Self Evaluation

Complete the following sentences by selecting the correct words. Check your answers with the correct answers at the end ot this Lab Sheet.

1. A good conductor should have resistance which is (very low) (very high).

2. A conductor which measures infinite ohms is (shorted) (open) (short).

3. A conductor which measures very low resistance end to end has (continuity) (an open) (been cleaned).

4. A conductor which has an electrical path, not shown on the schematic drawing, to another circuit is said to be (open) (shorted) (special).

5. A good fuse should measure, with an ohmmeter, (very low ohms) (open).

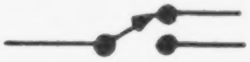
6. A good lamp should measure, with an ohmmeter, (very low ohms) (open).

7. When first measuring the resistance of a circuit with the VTVM, it may be necessary to (call for help) (change ranges on the ohmmeter and recalibrate).

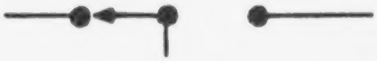
8. When using the VTVM ohmmeter to check for a short, the VTVM should be on the (Rx1) (Rx1Meg) range.

9. When using the VTVM ohmmeter to check for an open, the VTVM should be on the (Rx1) (Rx1Meg) range.

10. These are the schematic representations for a (SPDT) (STOP) (SPST) switch.



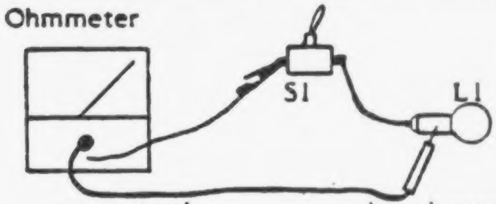
or

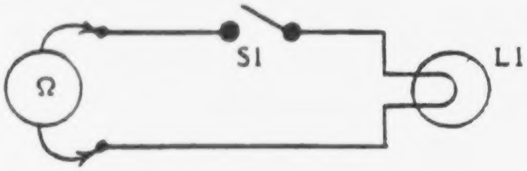


Below are shown some schematics of simple circuits with an ohmmeter. Given in each question is the value measured by the ohmmeter. Each circuit has one of three conditions: (1) normal circuit (that is, there is no trouble), (2) an open circuit, or (3) a short between circuits.

Select the best answer that will account for the ohmmeter reading.

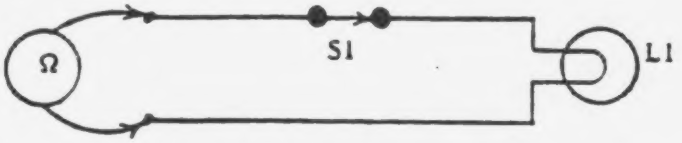
11. The ohmmeter measures infinite ohms. Probably the circuit is ___





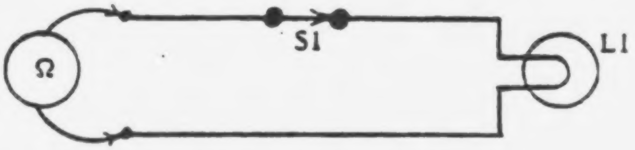
a. normal. b. shorted. c. open.

12. The switch is "on" and the ohmmeter measures infinite ohms. Probably ___



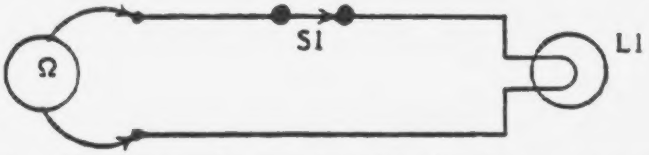
a. this is normal. b. the switch is shorted. c. the lamp is "burned out".

13. The switch is "on" and the ohmmeter measures infinite ohms. Probably ___



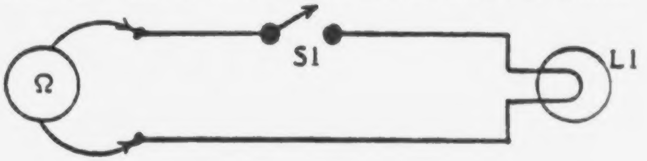
a. this is normal. b. the switch has an open contact.

14. The switch is "on" and the ohmmeter measures infinite ohms. Probably ___



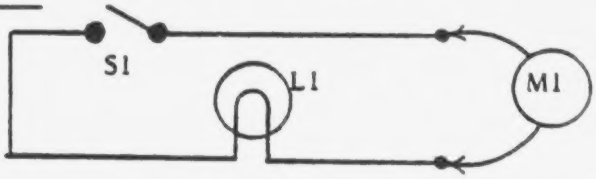
a. this is normal. b. the conductors for the circuit have an open.

15. The switch is "off" and the ohmmeter measures infinite ohms. Probably ___



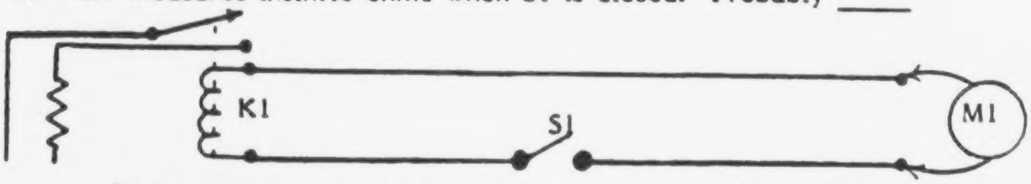
a. this is normal. b. the switch is shorted. c. the lamp is open.

16. Ohmmeter M1 measures infinite ohms when S1 is closed ("on").
Probably _______



a. S1 is shorted. b. L1 is shorted. c. L1 is open.

17. M1 measures infinite ohms when S1 is closed. Probably _____

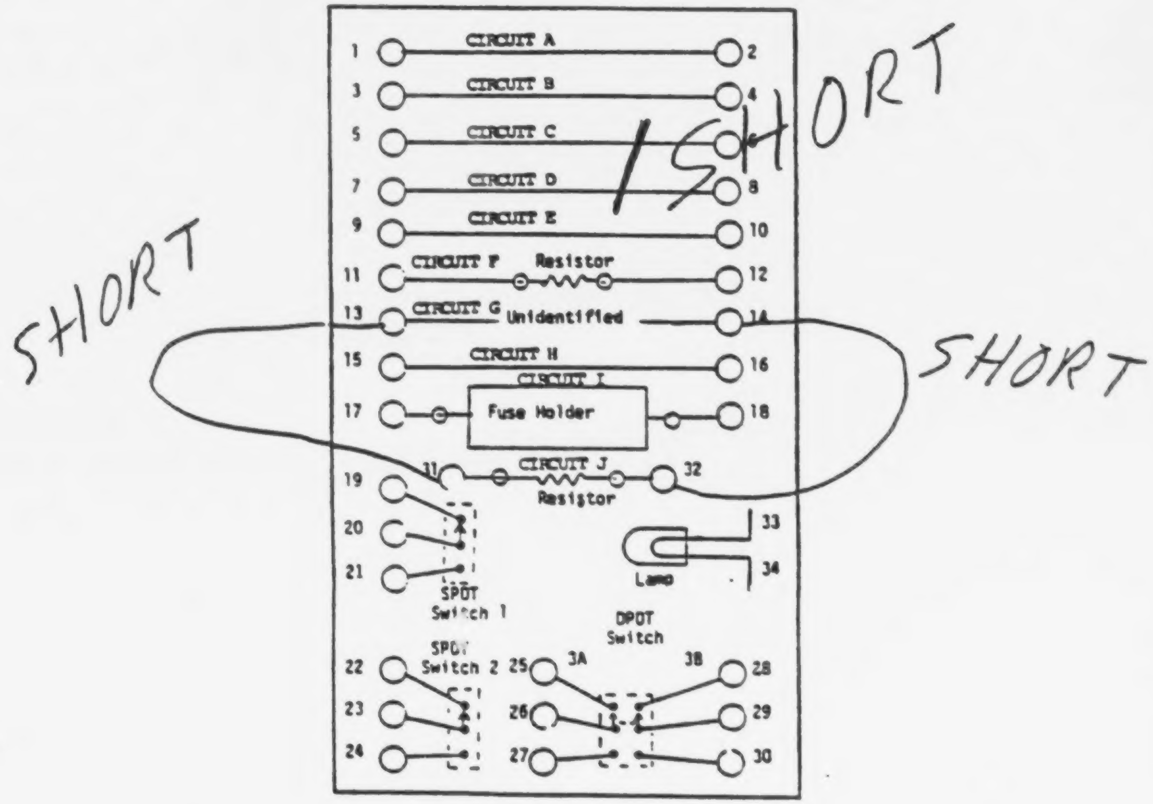


a. S1 is shorted. b. K1 is shorted. c. K1 is open.

Answers to PROJECT 5: Self Evaluation.

1. very low.
2. open.
3. continuity.
4. shorted.
5. very low ohms.
6. very low ohms.
7. change ranges on the ohmmeter and recalibrate it for that range.
8. Rx1
9. Rx1Meg
10. SPDT
11. C
12. C
13. B
14. B
15. A
16. C
17. C

Correct response to PROJECT 2, step 1f:


CIRCUIT A
CIRCUIT B
CIRCUIT C
CIRCUIT D
CIRCUIT E
CIRCUIT F
Resistor
CIRCUIT G
Unidentified
CIRCUIT H
CIRCUIT I
Fuse Holder
CIRCUIT J
Resistor
Lamp
SPDT Switch 1
DPDT Switch
SPDT Switch 2
3A
3B
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
SHORT
SHORT
SHORT

NAME: ______________________ Test # __________

UNIT EXAM

THE FLOW OF ELECTRICITY THROUGH CONDUCTORS AND INSULATORS

IMPORTANT:

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. A conductor provides a path through which electrons can freely flow. (T - F)

2. Plastic is a common conductor used on wires. (T - F)

3. Semiconductors contain five valence electrons. (T - F)

4. An insulator offers a difficult path for electron flow. (T - F)

5. Gold has the lowest resistance to current flow, and is known as the best conductor. (T - F)

6. The "effect" of an electric current moves at approximately the spped of light. (T - F)

7. Semiconductor materials have few uses in the field of electronics, and thus are not important substances. (T - F)

8. In order to cause electrons to flow through a wire, a voltage must first be applied. (T - F)

9. Stranded wire consists of one very flexible contral conductor coated with an insulator, such as rubber. (T - F)

10. Electrons flow through a curcuit from negative to positive. (T - F) (T - F)

11. Copper and aluminum are the two most commin conductor materials. (T - F)

12. Insulators, such as glass, and ceramic are used when very high voltage is present. (T - F)

13. The best conductor for general electronic work is:
a. copper b. aluminum c. silver d. tin

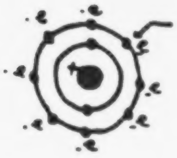
14. Good insulators:
a. have 8 electrons in their valence shell, b. are componds, c. do not conduct electricity, d. all of the above.

15. A semiconductor acts:
a. as an insulator at high temperature, b. as either an insulator or conductor, c. as a conductor when it contains no impurities, d. all of the above.

CONDUCTOR & INSULATOR

CHAIN REACTION	: chuỗi phản lực.
EVENT :	Biến cố.
OCCUR :	xẩy đến
ORDER :	Thứ tự
DUE :	đúng ; tới thời hạn.
DOMINOES :	Bài cầu.
CHEMICAL (a) :	về hoá học.
STABILITY :	sự vững chắc.
INDICTION :	sự buộc
ATOM'S TENDENCY	: khuynh hướng của nguyên tử.
MIX :	Trộn
REACT :	chống lại, phản lại.

A FULL VALENCE SHELL : (8 outer ELECTRONS) : chỉ viền ngoài của một nguyên tử có độ bền vì có đủ 8 âm điện tử.



chỉ âm điện tử ở vòng ngoài

STABLE (a) : ≠ UNSTABLE	Kiên cố, vững chắc
VALENCE :	viền bên ngoài của nguyên tử
ACTIVE :	hoạt động, chủ động.
CONDUCTOR :	chất dẫn điện
MATERIAL :	vật liệu
FLOW :	chạy (cường độ xuyên qua chất dẫn điện hoặc dây dẫn).
CONTAIN :	chứa đựng
FREE ELECTRONS	âm điện tử tự do.
METAL :	Kim loại.
DIELECTRIC = INSULATOR :	chất cách điện (không cho cường độ điện xuyên qua)
IMPULSE :	Kích thích
SIMULTANEOUSLY :	cùng một lúc.
LEAVE :	Rời bỏ, lìa bỏ.
REACTION :	chống lại sự hoạt động ; phản-lực.
CONTINLES :	Tiếp Tục.

AT THE SPEED OF LIGHT	tại vận tốc ánh sáng 186,000 miles/sec = 300,000 Km/sec.
AS LONG AS PRESSURE IS APPLIED	sức ép dãi thĩ thực dụng.
PRODUCE	sản xuất, sinh ra.
THEREFORE	cho nên
PROVIDE	cung cấp
PATH	con đường (cho cường độ chạy)
COMPOUND	KẾT HỢP.
SEMICONDUCTOR	chất nửa dẫn điện mà cách điện như Silicon và germanium.
DEPEND ON	tùy thuộc
TEMPERATURE	nhiệt độ.
SPEED OF LIGHT	một sự kích thích điện, điện tử sẽ chạy trong chất dẫn điện bằng vận tốc ánh sáng

ATMOSPHERE	áp suất.
ESTABLISH	Thiết lập.
STRIPPING	sự bóc vỏ, lột vỏ từ chất dẫn điện hoặc dây.
DEFINITION	định nghĩa.
DEVELOP	mở mang
OWN WORDS	các chữ riêng.
TERM	Từ, ngữ, chữ.
UTILIZING	có thể dùng
EXPERIMENTAL	thực nghiệm
TECHNIQUE	kỹ thuật
RESEARCH	sự sưu tầm
CLASSIFY	xếp loại
EITHER	hoặc . . hoặc . . .
COPPER	đồng (chỉ kim loại)
PLASTIC	chất plastic
cloth	vải
STEEL	thép
enamel	đồ sứ
gold	vàng
silicon	khuê tố
glass	thủy tinh
ceramic	ngói
silver	bạc

GERMANIUM	chất Germanium là chất semiconductor.
ALUMINUM	nhôm
mica	chất mê ca, nhựa
paper	giấy
carbon	Than
wood	gỗ
AIR	không khí
LEAD	chì
paraffin wax	chất paraffin
Tin	Thiết.
Soft	mềm
STRIPPER	bóc vỏ
REMOVE	dời, tách ra.
DESirable	làm vừa ý
FEATURE	đặc sắc
SOLID WIRE	dây cứng
STRANDED WIRE	dây mềm
ADVANTAGE	Tiện lợi.
CORD	dây thừng
HEAVY	nặng
GAUGE	cỡ (dây)
Thin ≠ Thick	mỏng ≠ dầy

ASBESTOS	chất thạch ma.
LOAD	gánh vác
ENTER	vào
ENERGY	năng lực
STRUCK	đập
TRANSFERRED	được vận chuyển
UNTIL	cho đến
ROW	hàng
RESIDENT	cư trú
EFFECT	Tác dụng
Exit	tồn tại
occur	xẩy đến
RAPID	nhanh
SEEM	dường như
PEculiar	đặc biệt
individual	cá nhân, riêng
appropriate	để riêng ra
approximate	độ chừng
purpose and appliance	mục đích và ứng dụng.
Insulation	chất cách điện
factor	yếu tố
considered	được coi như là.

selecting	việc chọn lựa
path or highway	con đường hoặc xa lộ cho điện chạy (vì vận tốc nó rất nhanh)
movement	sự di-chuyển
covered	được bao, bọc
within	bên trong

Industry	kỹ nghệ
bunch	chùm
group	nhóm
Twist	xoắn lại.
flexibility	sự uốn, mềm, kéo sợi.
strand	chảy
weak	nhược điểm, yếu

CONDUCTOR + INSULATOR = WIRE

chất dẫn điện + chất cách điện = dây điện

CONDUCTOR − INSULATOR = BARE WIRE

chất dẫn điện − chất cách điện = dây trần không có chất cách điện bao ngoài.

handle	xử dụng bằng tay.
yet	ngoài ra
a lot of	nhiều
necessary	cần thiết
kind	loại
variety	sự khác nhau
outside	bên ngoài
Extending	kéo dài
device	kế hoạch
securely	một cách chắc chắn, bảo đảm

destroy	phá hủy
associate	kết hợp
various	đổi khác
prevent	ngăn cản
covering	sự bao phủ
determine	xác định
diameter	đường kính
hence	vì vậy
purchase	mua
increase	tăng
manufacture	chế tạo

LII-U8-7

導体及绝缘体 CONDUCTORS AND INSULATORS

技術語彙

連鎖反应(CHAIN REACTION)：由於某种力量引發出一連串的行為發生，例如骨牌排列的傾倒或电子流过电線均為通例.

化學安定性(CHEMICAL STABILITY)：原子欲與其他原子结合或反应的一种趨勢，一般講，原子的价殼層置滿(最多8個)則十分安定而不会有化學或电學的反应，相反的，若其价殼層只有1個电子則十分不安定而具有高度的化學或电學反应行动能力，

導体(CONDUCTOR)：能讓电流很容易流过的物体。導体内有許多 自由电子(free electrons)而產生电的流通。最好的導体是 金屬物，它各个原子内只有一個价电子(one valence electr

电介体(DIELECTRIC)：绝缘体的另一名称，所以一個电介体物 也就是絶缘体物质。

电氣脉衝(ELECTRICAL IMPLUSE)：由一个电子被排入導线，同 時使另一电子被擠出導线的連續动作。這种电氣脉衝 連鎖反应只要引發的推力(pressure)一直存在則為連 地以光速在導線内進行。

自由电子(FREE ELECTRON)：被电氣压力(electrical pressure) 推離价殼層而自由地在導線内移动的电子謂之。許多自由电子同方向移动就產生了我们所講之电流，

绝缘体(INSULATOR)：不使电流通过的物体謂之。绝缘体 内的自由电子太少以致不能產生电子在其本体内自由 动，最好的绝缘体是其原子具有8個价电子，如塑膠， 璃等物体。

LII-08-9

半導体(SEMICONDUCTORS):一物体依所受的温度或其化学純度而能具備導体或絶緣体的行為能力。半導体的原子含有4個价电子.例如矽及鍺等物体。

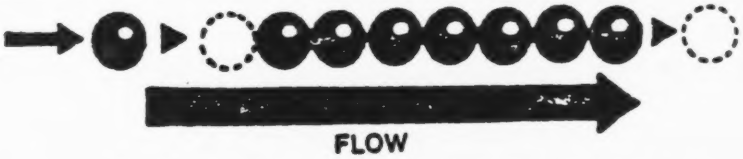
光速(SPEED OF LIGHT):光在大気中行進的速度.其被測出大約每秒鐘300,000,000公尺、依实驗得知在導体内的电気脈衝就是以光速来進行的。

剝除塗層(STRIPPING):將电线或導体外包覆的絶緣体(塑膠 plastic, 布 cloth, 琺瑯 enamal)剝掉。

LII-US-IC

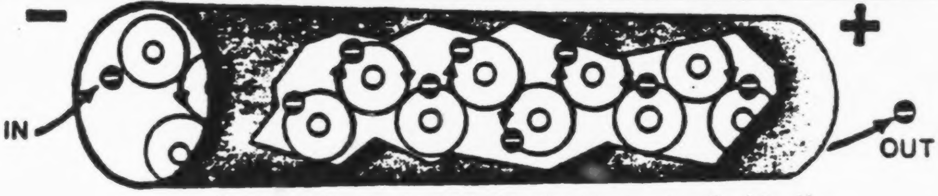
电流流经導体 CURRENT FLOW THROUGH A CONDUCTOR

电子在电路或導体中有规律地流动而産生。电気世上的电流你会发现每次当一个电子被推入導线中则同時在另一端的一个电子被推出導线。如下図具动力的弹子球在一條軌道上的滚动.



当第一个球被推动，具力量沿軌道经由一个球傳至另一个球地至最後一个球被推出.

在銅導体中，銅原子内价电子就如同弹子球般。当电压或电源供应時则強迫使一个电子進入導线，這个电子则推入最靠近的价殼層而把原置在這价殼層的一个电子推出該殼層，這被推出的电子又推入另一最近的原子的价殼層亦将另一电子推出，此种連續的动作直到有一个电子由另一端被推出該導线。說來這动作似乎很複雜，但其進行得十分快速，高達每秒300,000,000公尺有如光速。



上図的电気現象即表示电気脈衝

看起來有些特異，一一單独的电子在導线中移动很慢，大约是每秒10.92公厘(4.29英吋)，但当總电流移动時其速度则高達光速约為

186,000 miles/sec.

LII-US-11

电线：目的及应用 WIRE: PURPOSE AND APPLICATIC

目的：

導线(电线)是电路中主要部份，所以当你要选用導线時应該查阅下列重点。

導线提供电子通流的路线(如高速公路)，大多數導线均被覆一層绝缘物以保護电流安全地在導线内。

導体 + 绝缘物 = 導线

導体 - 绝缘物 = 裸线

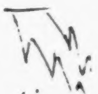
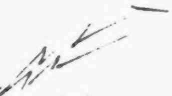
導线种類：

实线(单线)(solid wire)通常由一條细銅线做成，其容易操作及焊接。但若需要多次彎扭动作時，则不適用。你可以買到不同颜色及粗细的单线。组件如电阻器(resistor)，电容器(capacitors)感应体(inductors)等均具实线貫穿其中以利確实置於电路中

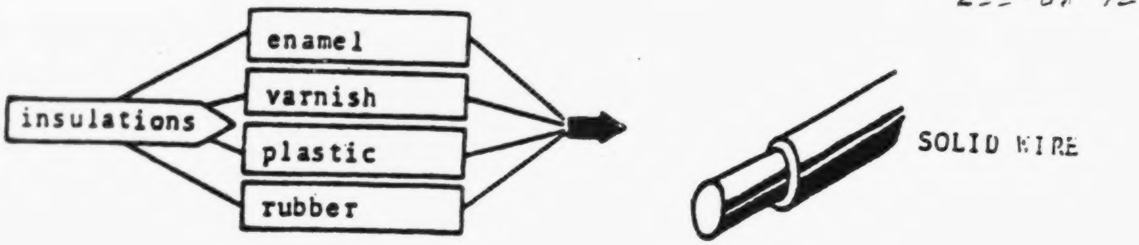
应用例舉：在家庭，学校，工廠的牆内的电器线路均是用單线。

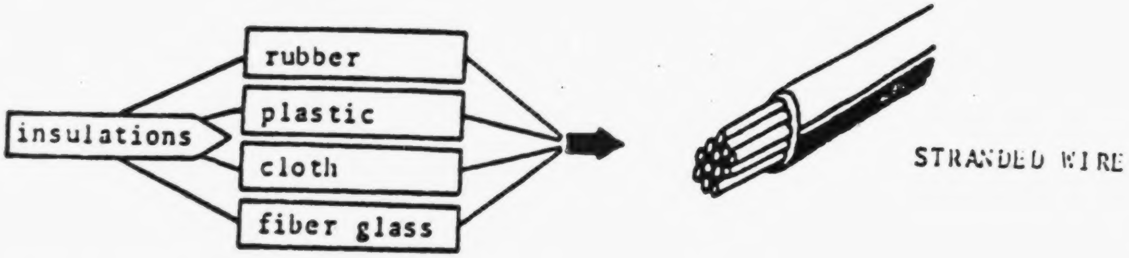
多股絞合线(stranded wire)：多條銅线相互纏扭在一起，看似一條线。若需要多次扭动時，则用此种導线。要注意的是当你纏扭時不要將各个单股扭断，否则会使絞合线不夠堅固也無能力載荷全部电流。一般在接置於电路上時都要將絞合线鍍錫(solder)。

应用舉例：多股絞合线用在电纜(cable)，儀錶线(appliance)及延长线(extension cord)。

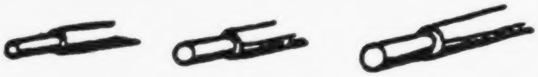
導线绝缘被覆(wire insulation) -  保護 

大多數導线外都包覆一層某种绝缘物以防止短路(short circu 及危險的意外发生，看看下頁各种不同類型的被覆绝缘物製成的導线。


insulations
enamel
varnish
plastic
rubber
SOLID WIRE


insulations
rubber
plastic
cloth
fiber glass
STRANDED WIRE

WIRE SIZES -



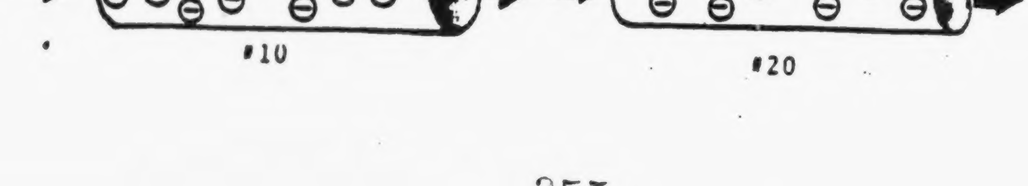
導綫粗细 (WIRE SIZE)

美國導綫尺規(American Wire Gauge, AWG)數值是用數
的大小有系统地規化導綫的粗细,數值愈大的導线就愈细
值愈小的導綫就愈细。选用適当粗细的導线来应用是十分重要.

注意:導綫尺規(wire gauge)是用来量導线粗细的工具。

粗细舉例:#20号導綫載荷的电流比#10号導线要少,因為#20号
线比較细所以只能讓較少的电流通过。

導线通論:现代大多數導线均用銅来製成,因为銅是一种优良的
电氣導体,並且價錢公道。銀比銅要更好,但是价錢
太貴而会增加成本,故很少选用.



LII-U8-7

字彙——定義了解

用你自己的話写出下列名詞的定義：

1. CONDUCTOR：

2. INSULATION：

3. SEMICONDUCTOR：

4 FREE ELECTRON：

下列字彙，須加圖以加強你的"文字"定義

5 CHAIN REACTION：

6. ELECTRICAL IMPULSE：

LII-118-8

了解測驗 (QUEST ACTIVITY)

第8單元

利用簡單的实驗技術(連續性試驗，歐姆計，簡單串联燈泡电路或研讀程序(教科書或化學參考書)標明下列物質何為導件，絶緣体或半導体，將你測試的結果写在長方欄内。

1. copper
2. plastic
3. cloth
4. steel
5. enamel
6. gold
7. silicon
8. glass
9. ceramic
10. silver
11. germanium
12. aluminum
13. mica
14. paper
15. carbon
16. wood
17. air
18. lead
19. paraffin wax
20. tin

21. 導体应用的目的：

22. 绝缘体应用的目的：

23. 列出三种最佳的电流導体： 23. A 23. B 23. C

24. 最普遍用来做电氣導线的是軟质的 ______ 24.

25. 導体含有許多 ______ 电子 25.

26. 最普遍的半導体是矽及 ______ 26.

27. 導线剥塗器是設计用於将 ______ 從導线上剝去. 27.

28. 写出單线的特点

29. 写出多股絞合线比实线較佳之處.

30. 当一电力电缆是用小數值(heavy gauge)电线包以厚塑膠绝缘体或石棉布(asbestos cloth)绝缘這表示該电缆电負荷如何?

ELECTRONIC C CULUM
VOCATIONAL TRAINING L N PLAN # VII Components & Switches

Teaching Materials Source ____
Chapter ____, pages ____
Lab Manual pages ____
Additional Instructor Materials ____

Main concepts student will learn:

The student will be able to:

1. identify and explain the general technical function of the following common components: resistor, inductor, capacitor, switch, speaker, xenon flashtube, neon lamp, transformer, and diode.
2. demonstrate basic circuit construction skills by physically manipulating electrical devices into either series, parallel, or combination circuit configuations.
3. perform basic inspection and troubleshooting steps in order to locate a defective or abnormal circuit condition.

Technical Vocabulary

see Glossary

Related General Vocabulary

Teaching Activity

1. Investigate with the class a variety of components that they might typically encounter when building a simple project.
2. Stress that many types of switches are used to control electricity. Try to collect and display switches of different physical conformation and function.
3. Review the essential parts of a circuit.

Materials and Notes

Students are working on components and switches while they are also working on projects they started in Unit III.

Length of Lesson

1 week

Evaluation

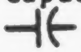
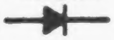
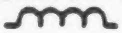
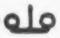
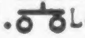
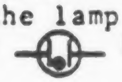
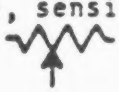
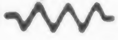
The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

Name: ______________

Date: ______________

COMPONENTS, SWITCHES. Period: ______________

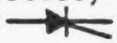
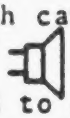
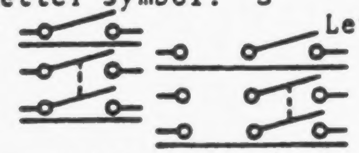
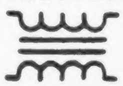
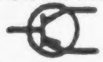
TECHNICAL GLOSSARY

ABNORMAL CIRCUIT:	A circuit which is not functioning properly. An abnormal circuit is generally open (a broken current path) or shorted (an undesired current path).
CAPACITOR:	An electronic component made up of two metal plates separated by an insulator. Capacitors have the ability to store a charge. Symbol:  Letter symbol: C
CLOSED CIRCUIT:	Any electrical circuit which contains a complete path for current flow from the negative terminal of the source to the positive terminal.
DIODE:	A semiconductor device which acts as a one way valve to current flow. Symbol:  Letter symbol: D
INDUCTOR:	An electronic component made by wrapping a coil of wire around an air or iron core. An inductor opposes any change in current flow. Symbol:  Letter symbol: L
MOMENTARY SWITCH:	A type of switch which is operated by pushing on a lever or button. Once the pressure is removed, the switch is "turned off." Momentary-contact switches are often push button type switches, and are available as either normally open or normally closed devices. Symbol: P.B.N.C.  P.B.N.O.  Letter symbol: S
NEON LAMP:	A glow lamp which contains neon gas. When a voltage of approximately 55 volts is applied to the lamp, the neon gas ionizes and glows orange. Symbol:  Letter symbol: LP
NORMAL CIRCUIT:	A circuit which is functioning properly, and provides a complete path for current flow.
OPEN CIRCUIT:	A circuit which contains a break or gap in the current path. The "break" will stop the circuit from operating.
PARALLEL CIRCUIT:	A circuit which contains two or more paths for current flow, sometimes referred to as a shunt or branch circuit.
POTENTIOMETER:	A variable resistor commonly used as volume, sensitivity, or speed control on many projects. Symbol:  Letter symbol: R
RESISTOR:	A simple, yet important, electronic component made from either carbon, wire, or metal oxide, and used to provide a specific opposition to current flow. Symbol:  Letter symbol: R

Name: ____________________

Date: ____________________

Period: ____________________

SERIES CIRCUIT:	A circuit which allows only one path for current flow. Components connected in series are joined in a line, one after the other.
SERIES PARALLEL CIRCUIT:	A circuit consisting of one or more series and parallel paths. Series-parallel circuits are often called combination circuits.
SHORTED CIRCUIT:	A circuit which contains a low resistance path between two points (power supply terminals, line, etc.), which causes excessively high current flow and possible circuit damage. A shorted circuit is usually caused by an accidental connection.
SILICON CONTROLLED RECTIFIER:	A three terminal electronic component belonging to the "diode family," and having the ability to electronically switch on and off, fairly large currents. Symbol:  Letter abbrev.: SCR
SLIDE SWITCH:	A style of switch in which a bar of metal is made to move or slide, making contact between two points--either opening or closing the circuit. Slide switches are generally low in cost.
SPEAKER:	An electronic component which can convert electrical signals into sound. Symbol:  Letter symbol: SPKR
SWITCH:	An electronic component used to control or direct current flow. Most commonly, switches are used to open or close a circuit path. Switches are available in many styles and configurations, such as push-button, slide, toggle, micro, rotary, single pole single throw, double pole single throw, single pole double throw, double pole double throw, etc. Letter symbol: S Symbol:  Letter abbrev. SPST SPDT DPST DPDT
TOGGLE SWITCH:	A common switch style which uses a "snap action" principle to move a set of contacts from one side of the switch to the other, opening or closing the circuit.
TRANSFORMER:	An electronic component able to either step-up (increase) or step-down (decrease) an AC voltage. Symbol:  Letter symbol: T
TRANSISTOR:	An electronic component which can be used to amplify an electric signal. Transistors are also used as high speed switches. Symbol:  Letter symbol: Q
XENON FLASHTUBE:	A special purpose lamp, capable of producing a brilliant flash of light. Xenon flashtubes are found in strobe lights and photographic strobes.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - SPELLING PUZZLE

Copy the correctly spelled word in the box at the right. As indicated in the example below.

A. (ampmeter) (ammeter) (ameter) A. ammeter

1. (curcuit) (sircuit) (circuit) 1. ☐

2. (diode) (dyode) (diold) 2. ☐

3. (siries) (ceries) (series) 3. ☐

4. (tagole) (toggle) (toggel) 4. ☐

5. (speaker) (speeker) (speker) 5. ☐

6. (switch) (swich) (swit) 6. ☐

7. (parelel) (parallel) (parrallel) 7. ☐

8. (silicon) (silecon) (silacon) 8. ☐

9. (capasetor) (capaciter) (capacitor) 9. ☐

10. (normel) (normol) (normal) 10. ☐

11. (inducter) (inductor) (enductor) 11. ☐

12. (momentary) (monantary) (momintary) 12. ☐

13. (tramsister) (transister) (transistor) 13. ☐

14. (rectifire) (rectifier) (recktifier) 14. ☐

15. (potenteometer) (potentimeter) (potentiometer) 15. ☐

SCORE:

GRADE:

Name:

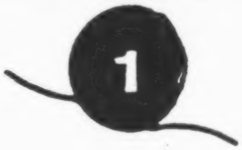
Date:

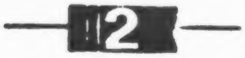
Period:

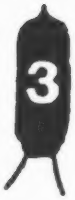
WORKSHEET

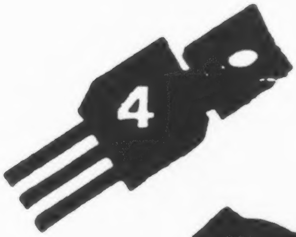
COMPONENT IDENTIFICATION

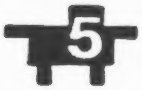
Identify the component drawings shown below.

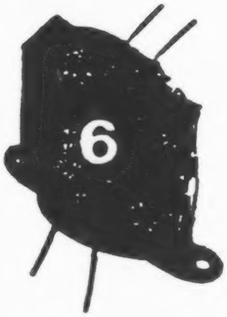
1.


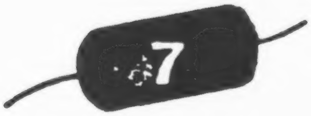
2.


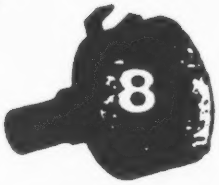
3.


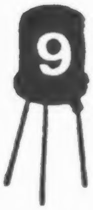
4.


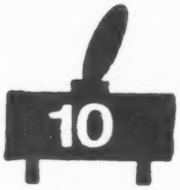
5.


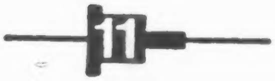
6.


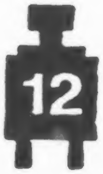
7.


8.


9.


10.


11.


12.


1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

QUEST ACTIVITY

"UNIT 11"

Use the component puppets provided on page three to construct the circuits described below. You will cut out and arrange the puppets to form series, parallel, and series-parallel circuits. You must draw in interconnecting lines to represent conductors. Be sure that each problem fulfills the four requirements for a complete electric circuit - i.e. supply, control, load, and conductor.

1. Construct a series circuit, utilizing a ~~1.5~~ 6 volt cell to supply power, a SPST switch to control current flow, and two lamps as load devices.

2. Design a parallel circuit, using a ~~110V~~ 6 source, and a SPST switch as an on-off control. The circuit is to contain three branches, each branch will operate a different load device.

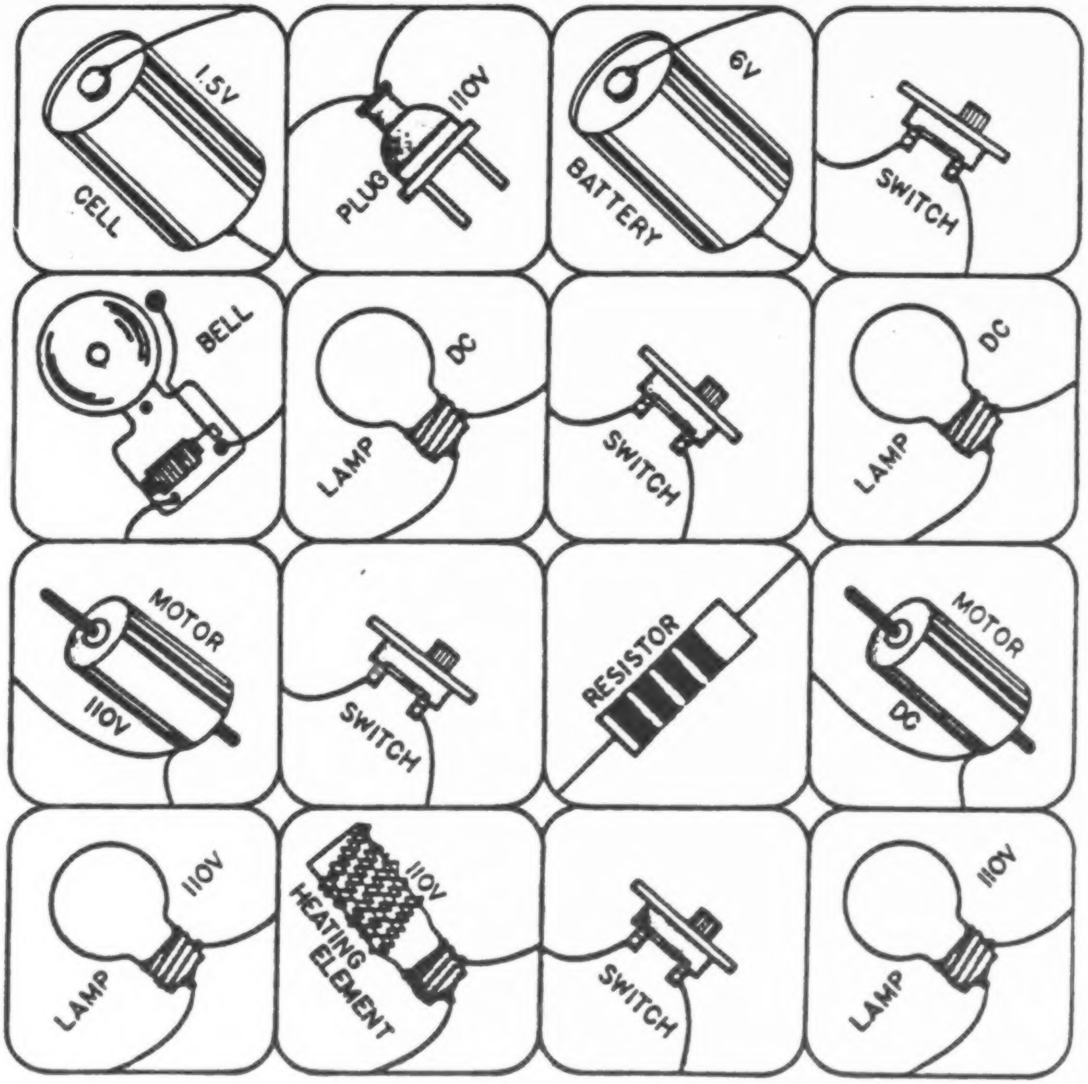
Name: ____________________

Date: ____________________

Period: ____________________

Assemble a series-parallel circuit consisting of two series loads, and two parallel loads. The circuit operates on 6V DC, contains a SPST switch which will de-energize the total circuit, and a SPST switch to control one of the parallel loads. You may utilize any four appropriate load devices.

Component Puppets


1.5V
CELL
110V
PLUG
6V
BATTERY
SWITCH
BELL
DC
LAMP
SWITCH
DC
LAMP
MOTOR
110V
SWITCH
RESISTOR
MOTOR
DC
110V
LAMP
110V
HEATING ELEMENT
SWITCH
110V
LAMP

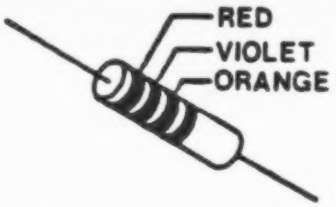
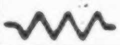
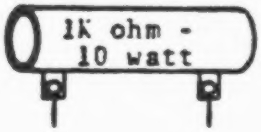
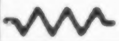
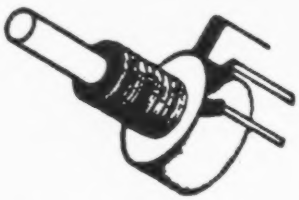
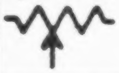
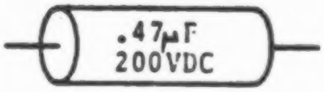
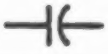
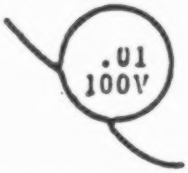
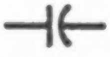
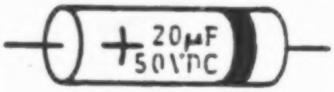
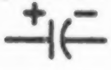
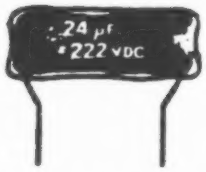
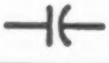
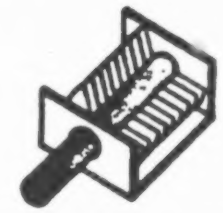
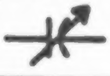
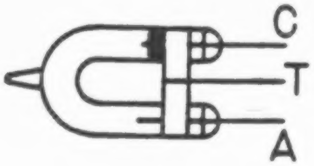
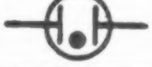
Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

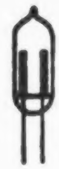
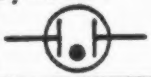
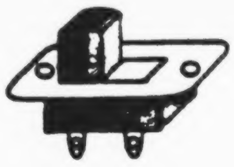
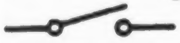
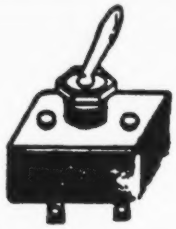
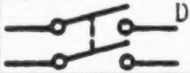
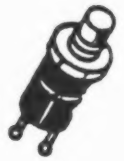
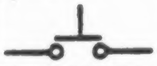
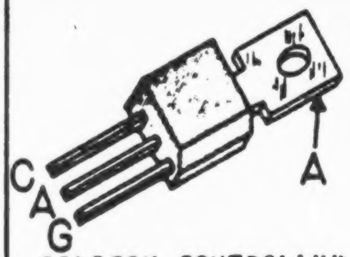
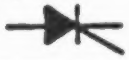
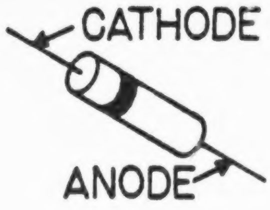
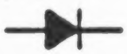
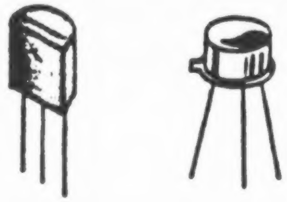
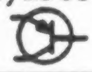
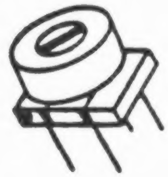
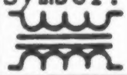
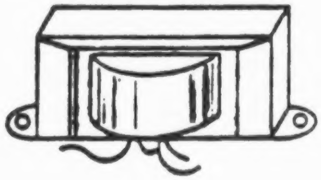
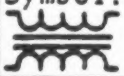
BASIC ELECTRONIC COMPONENTS USED IN PROJECT CONSTRUCTION

 RED VIOLET ORANGE CARBON COMPOSITION RESISTOR Symbol:  Letter Designation: R	 1K ohm - 10 watt POWER RESISTOR Symbol:  Letter Designation: R	 POTENTIOMETER Symbol:  Letter Designation: R
 .47µF 200VDC TUBULAR CAPACITOR Symbol:  Letter Designation: C	 CERAMIC OR DISC CAPACITOR Symbol:  Letter Designation: C	 ELECTROLYTIC CAPACITOR Symbol:  Letter Designation: C
 .24 µf 222 VDC MYLAR CAPACITOR Symbol:  Letter Designation: C	 VARIABLE CAPACITOR Symbol:  Letter Designation: C	 XENON FLASHTUBE Symbol:  Letter Designation: LP

Name: ____________________

Date: ____________________

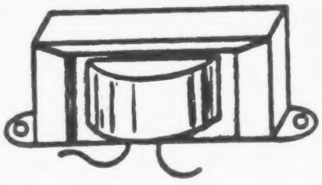
Period: ____________________

 **NEON LAMP** Symbol:  Letter Designation: LP	 **SPST SLIDE SWITCH** Symbol:  Letter Designation: S	 **DPST TOGGLE SWITCH** Symbol:  Letter Designation: S
 **N.O. PUSH-BUTTON SWITCH** Symbol:  Letter Designation: S	 **SILICON CONTROLLED RECTIFIER** Symbol:  Letter Designation: SCR	 **SEMICONDUCTOR DIODE** Symbol:  Letter Designation: D
 **TRANSISTOR** Symbol:  Letter Designation: Q	 **TRIGGER TRANSFORMER** Symbol:  Letter Designation: T	 **TRANSFORMER** Symbol:  Letter Designation: T

Name: ____________

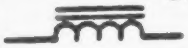
Date: ____________

Period: ____________

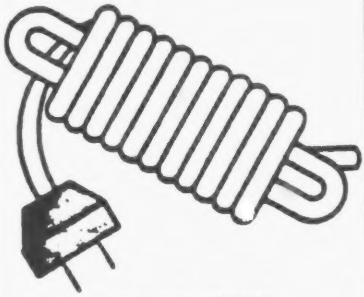


INDUCTOR (COIL)

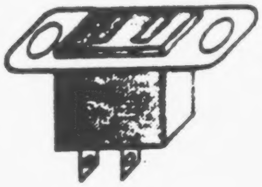
Symbol:



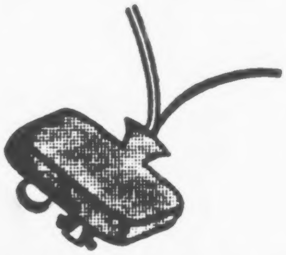
Letter Designation: L



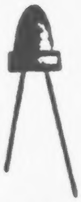
AC LINE CORD



ELECTRICAL OUTLET

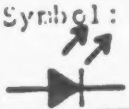


BATTERY CONNECTOR

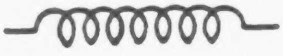


LIGHT EMITTING DIODE

Symbol:



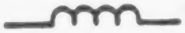
Letter Designation: D



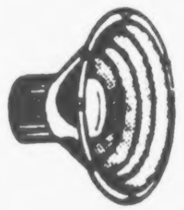
INDUCTOR (COIL)

air core

Symbol:

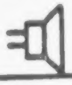


Letter Designation: L



SPEAKER

Symbol



Letter Designation: SPKR

Name: ________________

Date: ________________

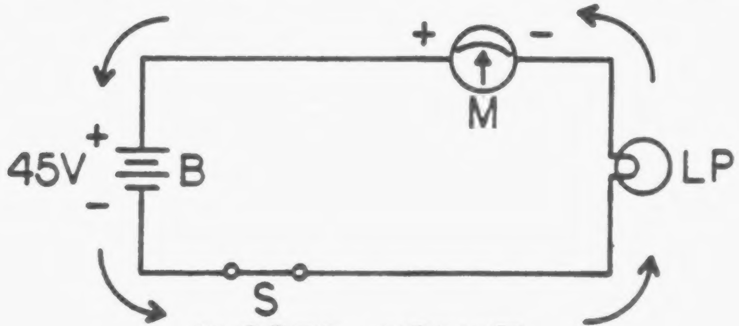
Period: ________________

INFORMATIONAL HANDOUT

NORMAL AND ABNORMAL CIRCUITS

The schematic below shows a typical circuit in which a DC voltage, "E", forces the current, "I", through a load device. This is called a closed circuit because all of the circuit parts are connected in a manner which allows an unbroken path for the flow of electrons. The load device (lamp) will operate properly and the circuit is considered normal in terms of operation.

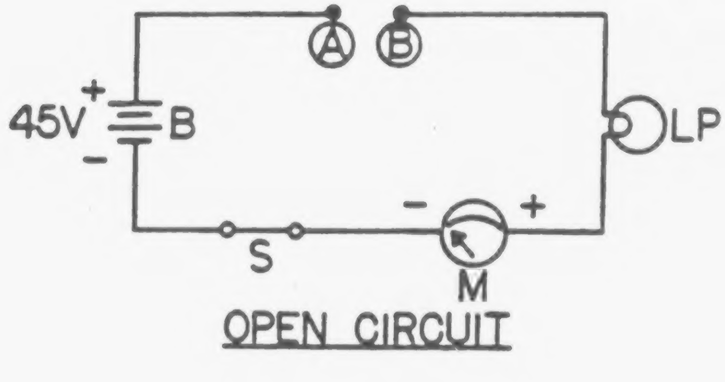
normal = closed



CLOSED CIRCUIT

The next circuit has been broken open between points A and B, hence, the term open circuit. Since electrons cannot jump the gap from A to B, no current can flow from the battery to the load device, thus the circuit is considered disabled. Closing a circuit usually means turning it on or placing it in operation; while opening a circuit means generally the act of turning a circuit off or that the circuit is nonfunctioning due to an abnormal circuit condition. Many times an open circuit has been created by a wire or component breaking in half and stopping the current flow.

abnormal = open



OPEN CIRCUIT

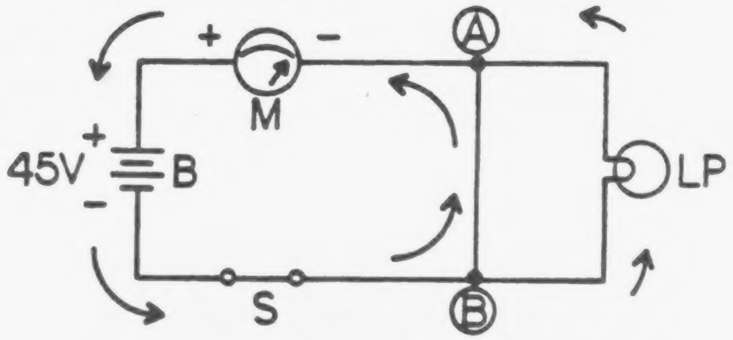
Name: ____________________

Date: ____________________

Period: ____________________

The last schematic indicates that a conductor has been accidently connected across the circuit from "A" to "B". Because of the lower resistance of the path between "A" and "B" most of the current (I) flows through this path, robbing the load device of its proper current flow. This condition often is spoken of by technical people as "electricity taking the path of the least resistance." We should know that most, not all, of the current flows through this abnormal path, however, because of the shorter route taken by the current in this case, path "A" to "B", this abnormal circuit is called a short circuit. Generally, short circuits are unintentional, being caused either by accident or by mistakes in wiring. A wire or piece of metal falling onto an electrical circuit can cause a short circuit. Short circuits must be avoided since they can cause damage to power sources and circuit components because of the large currents they create. A portion of a circuit as well as the whole circuit may become short-circuited, and in either case short circuits are ....DANGEROUS!!!!!!!!!

abnormal = shorted



SHORT CIRCUIT

REVIEW

A typical normal circuit is one which operates properly and usually contains the following:

1. A source of "E" and "I" ..... Supply.
2. A device to turn the circuit on or off .....Control.
3. A path for electricity to travel through ..... Conductor.
4. A device to operate ..... Load.

When a circuit does not operate right, it is said to be abnormal. There are two main types of defective or abnormal circuits that must be frequently repaired.

1. Open circuits
2. Shorted circuits

As a repair person you might often be asked to fix electrical products. The process of determining whats wrong is called troubleshooting. To troubleshoot quickly requires that you study the characteristics of abnormal circuits.

UNIT EXAM

THE LANGUAGE AND SYMBOLS OF ELECTRICITY

IMPORTANT:

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. On a schematic diagram, the components are shown as graphic symbols. (T - F)

2. The dot symbol on a schematic diagram is used to show that wires are electrically connected together. (T - F)

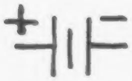
3. Abreviations, or letter designations are used to simplify component identification. (T - F)

4. A typical reference designation uses a number/letter code such as 3_R to designate resistor #3. (T - F)

5. Schematic symbols are used to illustrate electronic terms. (T - F)

IDENTIFY THE SCHEMATIC SYMBOLS DRAWN BELOW.

6.



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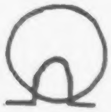

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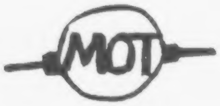

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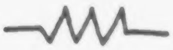

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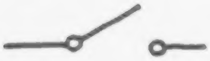

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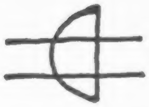

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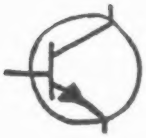

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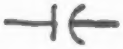


____

IDENTIFY THE ABBREVIATIONS OR LETTER DESIGNATIONS LISTED BELOW.

14. Ω ____________________________

15. T ____________________________

16. DC ____________________________

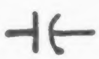
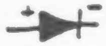
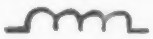
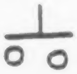
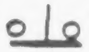
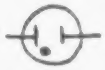
17. L ____________________________

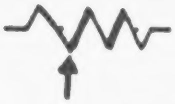
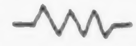
18. Q ____________________________

19. D ____________________________

20. GND ____________________________

Components & Switchs & Circuits

ABNORMAL CIRCUIT	mạch bất thường (mạch điện bị mở hoặc bị chạm)
CAPACITOR	Tụ điện được làm nên do hai đĩa kim loại được tách biệt bằng chất cách điện. Tụ điện có năng lực chứa điện tích. Dấu hiệu  Ký hiệu bằng chữ: **C**.
DIODE	lưỡng cực bán dẫn, hoạt động bằng âm điện tử trên con đường lưỡi gà (chớp-tắt) dấu hiệu  ký hiệu bằng chữ **D**
INDUCTOR	Cuộn cảm ứng điện được làm nên bởi dây đồng cuộn quanh một lõi sắt hay lõi không khí. Cuộn cảm ứng chống lại bất cứ sự thay đổi nào của cường độ chạy. dấu hiệu:  KH bằng chữ **L**
MOMENTARY SWITCH	Công tắc bấm bật  ngắt điện  mở điện dấu hiệu: S hay S_W
NEON LAMP	đèn chạy bằng khí NEON. dấu hiệu  KH bằng chữ: **LP**
NORMAL CIRCUIT	một điện bình thường cho cường độ chạy qua

OPEN CIRCUIT:	mạch điện bị ngắt không cho cường độ chạy qua.
PARALLEL CIRCUIT :	mạch song song, gồm hai hay nhiều mạch rẽ cho cường độ chạy.
POTENTIOMETER:	một điện trở biến đổi dùng để tăng giảm, có tính chất nhạy bén hoặc kiểm soát vận tốc cường độ chạy đến nhiều dự án. dấu hiệu  Ký hiệu bằng chữ: R
RESISTOR :	một bộ phận đơn giản nhưng quan trọng. Được cấu tạo bằng than, dây thép hoặc bằng oxýt sắt dùng để cản điện. Dấu hiệu  Ký hiệu bằng chữ: R.
SERIES CIRCUIT:	một mạch điện chỉ có một con đường cho cường độ chạy. Các bộ phận điện được nối tiếp nhau trong một đường cái này sau cái khác.
SHORTED CIRCUIT :	một mạch điện có 1 con đường cản điện thấp giữa hai điểm (giữa máy cung cấp điện và dây điện.) Nó gây ra cường độ rất mạnh và có thể gây thiệt hại mạch điện. Shorted circuit thì thường gây ra bởi một sự nối bất ngờ

QUEST ACTIVITY	Việc làm đòi hỏi phải thực hiện.
PICTORICAL DIAGRAM	biểu đồ bằng hình vẽ giống như vật thật
CONGESTED (adj)	ngăn trở, choáng chỗ.
APPEAR	xuất hiện
ALONG	Theo, dọc theo
NECESSARY	Cần Thiết
DESCRIPTIVE	Tính chất mô tả.
INFORMATION	lời chỉ dẫn, tin tức.
REPRESENT	Thay mặt, đại diện
UTILIZE	dùng
VARIOUS	Đổi khác, khác nhau.
THE SAME	Giống như, tương Tự
PROVIDE	Cung cấp
COMPLETE	hoàn thành
PROPER LOCATIONS	những vị trí riêng biệt.

INCLUDE	gồm, gồm có
AC LINE CORD	Đường dây điện xoay chiều.
NEON LAMP	Đèn nê-ông.
SWITCH	Công tắc điện.
CAPACITOR	Tụ điện.
RESISTOR	điện trở.
DIODE	đèn lưỡng cực.
CELL	pin
ILLUSTRATE	hình vẽ có chú giải
CURRENTLY ACCEPTED LETTER DESIGNATION	dấu hiệu dòng điện chạy vào bộ phận.
ELECTROLYTIC	điện giải.
FEMALE (J)	chấu, ổ điện.
MALE (P)	phích cắm điện.
CONNECTOR	chỗ nối điện (ổ)
Diode Rectifier(D)	lưỡng cực chỉnh lưu
(SCR): Silicon Controlled Rectifier	bộ chỉnh lưu Silicon.
Light Emitting Diode (LED)	lưỡng cực phát tuyến.
FUSE	Cầu chì.
GENERATOR	Máy phát điện.
GROUND (GND)	Mát, đất

Utilizing :	việc dùng, xài
Load :	gánh vác
on-off control :	cần kiểm soát tắt - mở điện.
branch :	nhánh điện.
operate :	thực hiện, Thi hành, chạy máy.
consisting :	gồm có
de-energize :	không kích thích.
Total circuit :	tổng mạch, mạch tổng
The parallel loads :	những gánh vác song song (tải điện)
Appropriate :	Thích đáng
Approximate :	độ chừng, phỏng chừng.
carbon composition Resistor :	điện trở than
Power Resistor :	điện trở công suất.
Tubular capacitor :	Tụ điện ống (Tubular)
Electrolytic capacitor :	Tụ điện điện giải
DPST TOGGLE SWITCH :	công tắc bật hai cực chạy qua một đầu dây điện.
SEMICONDUCTOR DIODE :	Đèn hướng cực bán dẫn (có 2 cực âm cực và dương cực)
Battery connector :	Đầu nối pin.
AC line cord :	dây điện AC
Electrical outlet :	ổ cắm điện.
Inductor (coil) :	cuộn cảm ứng điện từ.
manner :	kiểu
Jump :	nhảy
gap :	lỗ thủng
disabled :	làm hư hỏng
created :	được xây dựng.
Hence :	từ đây
determine :	xác định
troubleshooting :	phiền toái
characteristic :	đặc tính, đặc sắc

Symbol

DẤU HIỆU & KÝ HIỆU

ABBREVIATION : Sự viết tắt một chữ hay một "từ" trong hình Thức rút gọn Luôn Luôn dùng chữ đứng đầu để thay thế cho một chữ hoặc một nhóm. Thí dụ : - Direct Current được viết tắt là DC

- Alternating Current " AC

DC : Điện một chiều như battery, cell ...

AC : Điện xoay chiều như điện 240V.

COMPONENT : Một bộ phận điện như Capacitor; resistor, transistor ...

CONNECTION : Chỗ hoặc điểm nối của 6,7 chất dẫn điện hay các bộ phận điện lại với nhau trong một mạch điện.

ELECTRICAL TERM :

Từ ngữ thuộc về điện (nó mô tả tính chất điện, đơn vị của sự đo điện, một bộ phận điện, hành động thuộc về điện ...).

LETTER IDENTIFICATION :

Một chữ dùng để một loại riêng biệt của bộ phận điện tử. Thí dụ : Capacitor là C. C là Capacitor được nhận rõ là một tụ điện; Resistor là R. R là Resistor là một điện trở.

NUMERICAL VALUE: Giá trị bằng số của một bộ phận được phát biểu trong đơn vị số đo của nó. Giá trị bằng số của Resistor một ngàn ohm là 1000 hay 1 Kilo.

REFERENCE DESIGNATION:

Dấu hiệu được dùng trong biểu đồ một mạch điện mà nó tượng trưng cho các bộ phận.

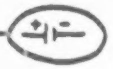
Thí dụ: trên biểu đồ (Schematic diagram) điện trở số ba sẽ được nhận rõ là R_3. (subscript) số 3 sau R còn gọi là số góp phần.

Reference	:	liên quan.
Designation	:	dấu hiệu.
Identification	:	Sự nhận rõ.
Subseipt	:	Ký nhận bằng số.
combine	:	Hợp lại.
particular	:	riêng biệt.
Type	:	Kiểu, loại.
Drawing	:	cách vẽ
Simplified symbols	:	những dấu hiệu đơn giản.
Physical layout	:	Vật đặt ở ngoài
structure	:	cấu tạo, xây dựng
Schematic symbol	:	Dấu hiệu được miêu tả trên biểu đồ.
Depiot	:	mô tả.
graphic	:	biểu thị, mô tả.

Decoded	:	được dịch ra tiếng Thường. (ở đây chỉ dữ từ Mật mã phải dịch ra theo Alphabet: A, B...)
Worksheet	:	làm việc trên tờ giấy. (cho sẵn)

Draw in the correct schematic symbol:

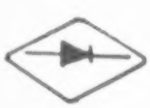
Thí dụ:

CELL —  Hãy vẽ dấu hiệu biểu thị đúng.

Fixed value	:	giá trị cố định
Adjustable	:	biến đổi, điều hòa được.

Identify the following graphic symbol.

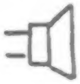
Hãy chỉ định dấu hiệu sau bằng biểu thị chữ.

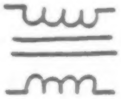
Thí dụ  ....DIODE RECTIFIER

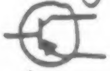
SERIES PARALLEL

CIRCUIT : một mạch điện gồm có một hay nhiều con đường nối tiếp và song song. Nó thường gọi là mạch kết hợp.

SLIDE SWITCH : một kiểu công tắc điện có thanh kim loại di chuyển hoặc trượt. Nó liên lạc giữa hai điểm hoặc đóng hoặc mở điện. loại này rẻ tiền.

SPEAKER : loa phóng thanh, nó biến đổi tín hiệu điện thành âm thanh. (Dấu) Ký hiệu 
Ký hiệu bằng chữ SPKR

TRANSFORMER: bộ biến thế dùng để tăng hoặc giảm điện thế xoay chiều. Ký hiệu  Ký hiệu bằng chữ: T

TRANSISTOR : một bộ phận khuếch đại tín hiệu điện. Nó thường xử dụng với cường độ điện cao
Ký hiệu  Ký hiệu bằng chữ Q

XENON FLASTUBE: một loại đèn chớp sáng đặc biệt thường tìm thấy trong đèn máy chụp, trong máy in lại giấy tờ.

construct : xây dựng
describe : mô tả
Arrange : xếp đặt

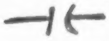
puppet : múa rối,
problem : vấn đề
Fulfill : làm đầy đủ
Requirement sự đòi hỏi.

HAND KEY	:	khoá tay
HEADSET	:	Bộ máy nghe mang vào đầu 2 bên chụp vào 2 tai.
CIRCUIT BREAKER	:	cái ngắt điện.
CONDUCTOR	:	dây, chất dẫn điện.
INDUCTOR	:	phần cảm điện
AIR CORE	:	bộ cảm kháng không khí,
IRON CORE	:	bộ cảm kháng lõi sắt.
INCANDESCENT LAMP	:	đèn tròn.
METER	:	máy đo.
MICROPHONE	:	bộ vi âm để Thu tiếng nói
MOTOR	:	động cơ điện
POLARITY	:	cực điện
RELAY	:	công tắc điện từ còn gọi: mối điện
RHEOSTAT	:	biến trở
TAPPED	:	nối, gắn (thay đổi được)
SINGLE POLE	:	một dây điện (một cực điện)
DOUBLE POLE		Hai dây điện (Hai cực điện)
THROW	:	chạy

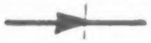
(SPDT)	:	Công tắc một dây điện nóng chạy qua một đường dây điện
(SPDT)	:	công tắc một dây điện nóng chạy qua 2 dây điện ở 2 bên.
(DPST)	:	Công tắc 2 cực chạy qua một đường điện
(DPDT)	:	công tắc 2 cực chạy qua hai đường điện 2 bên.
(PBNC)	:	công tắc nhấn nút mạch điện đóng kín
(PBNO)	:	công tắc nhấn nút (mạch điện) ngắt điện.
TRANSISTOR	:	bộ phận bán dẫn, khuếch đại.
TRANSFORMER	:	bộ biến thế.
cps	:	chu kỳ trên giây
EMF	:	điện vị khác nhau.
INPUT	:	nhập lượng
OUTPUT	:	phát ra
SINE WAVE	:	Sóng hình Sin
Positive	:	cực dương ⊕
Negative	:	cực âm ⊖
standard	:	Tiêu chuẩn
Adopted	:	được dùng
Institude	:	Viện
Electronic Engineer		Kỹ sư điện tử

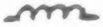
电子组件及開関（COMPONENTS and SWITCHES）
技術語彙

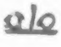
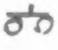
異常电路(ABNORMAL CIRCUIT)：电路運作不適当謂之。大多為断路(open
(电线断了)或短路(shorted)(無意中的接通之电线)

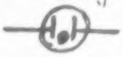
电容器(CAPACITOR)：两片金属中间用絶缘体分隔製成的电子组件
电容器具有蓄存电荷的功能。符号 ，文字代表：C

閉合电路(通路)(CLOSED CIRCUIT)：任何电路具備讓电流由电源
負極流向正極的完整线路。

两極管(DIODE)：一种半導体裝配成之组件具有电流单向閥之作用。
符号  文字代表、D

感应器(INDUCTOR)：用电线環繞空氣(心)或鉄(心)捲成的线圈的
电子组件。电感器(感应器)阻止电流的任何变化)。
符号  文字代表：L

瞬间開関(MOMENTARY SWITCH)：以指揮或按鈕為作用的一种
组件開関。当压(指)力消失則断開(turned off)。大多為按
鈕式瞬间開関。正常時為切断(normally open)或為通路
(normally closed)的配置均有。
符号：P.B.N.C. ；P.B.N.O.  文字代表：S

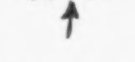
氖光燈(霓虹燈)(NEON LAMP)：內充有氖氣的发光燈。当供应电
压约為55伏特時則氖氣离子化而发橘色光。
符号： 文字代表：LP

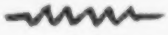
正常电路(NORMAL CIRCUIT)：电路能正常運作以及能提供
流完整的通路。

開路(断路)(OPEN CIRCUIT)：电路中有间隙或割開而停止电

的運作.

並联电路(PARALLEL CIRCUIT):擁有兩條或兩條以上能讓电流通过的线路之电路.有時又稱之為支电路.

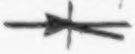
电位〃(分压器)(POTENTIOMETER):一种可变电阻器.用在调節裝備的音量(volume),靈敏度(sensitivity)或速度(speed).
符号  文字代表:R

电阻器(RESISTOR):由碳物质,电线或金属氧化物製作成的一种简单但很重要的电子组件.用以定訂电流流通所受抗阻的大小。 符号  文字代表:R

串联电路(SERIES CIRCUIT):只有一條能讓电流通过的线路之电路.其上之组件均一个結一个地串接在該线路上。

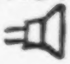
串並联电路(SERIES PARALLEL CIRCUIT):擁有一个或多个串联及並联的线路之电路.通常也稱"合併电路"(combination circuit)

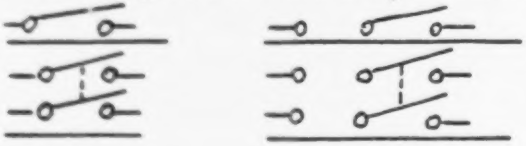
短路(SHORTED CIRCUIT):在电压供应端子之间或电路线上之兩点间有一條低电阻线連結,此现象会產生十分高強的电流,而可能损坏电路。通常短路是無意中連結上的.

矽可控整流器(SILICON CONTROLLED RECTIFIER)屬於兩極管類三个接线柱(端子)的电子组件,具有在大电流時电子性质的開関作用. 符号:  文字縮写:SCR

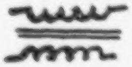
滑动開関(SLIDE SWITCH):以金属桿的拨动或滑动於兩点之间使电流能通或斷的一种廉價開関。

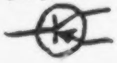
LII-U11-8

揚声器(SPEAKER):能將电氣信符轉換為声音的一种电子组件
符号 =  文字代表 = SPKR

開関(电鍵)(SWITCH):用以控制或定向电流流通的一种电子组件
用在開通或切斷一個电路。有許多不同型式及運作的開関.
如按鈕式(push-button). 滑动式(slide). 撥动式(toggle) 微
式(micro) 旋轉式(rotary) 單刀單投式(single pole single thro
双刀單投式(double pole single throw) 單刀双投式(single
pool double throw) 双刀双投式(double pool double throw)
符号:  文字缩写
SPST SPDT
DPST DPDT.
文字代表 = S

撥动開関(TOGGLE SWITCH):一种普通的開関,以"撥动"之原
理扳动在開関內之結連点,使电路通或斷。

变压器(TRANSFORMER):一种能增加或減弱交流电流的电子
组件. 符号  文字代表: T

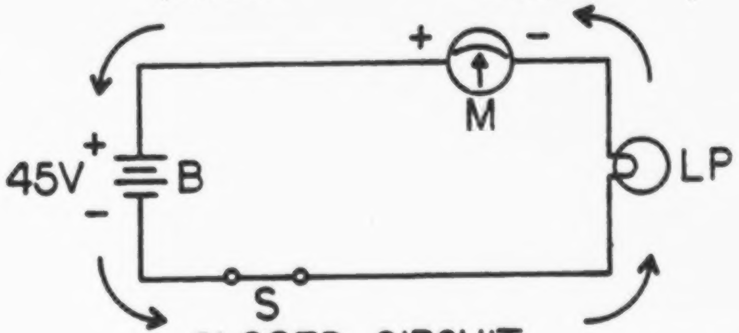
晶体(三極)管(TRANSISTOR):能擴大电氣信符的电子组件
又可作高速開関用. 符号  文字代表: Q

氙氣管(XENON FLASHTUBE):特别用途的燈管,能發白熾
閃光,用在照像閃光燈,

正常與異常电路 NORMAL AND ABNORMAL CIRCUITS

下圖標明一典型电路，其直流电压"E"推动电流"I"经过电负荷配件。此路作闭合电路(closed circuit)，因為全部的电路配件均联在一條电子通流不断的线路上。這电负荷配件(燈泡)将会運作並且电路也在正常運作。

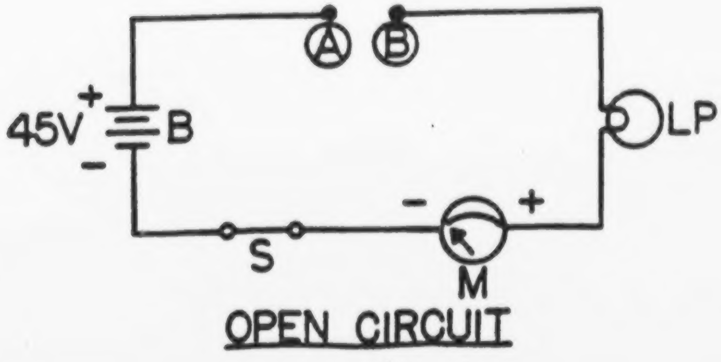
正常 = 闭合
Normal *closed*



CLOSED CIRCUIT

下圖电路在A與B点已切断，因此即謂断路(open circui
因為电子不能由A点跳躍过间隙至B点。沒有电流能由电池流至电负荷配件，因此本电路被認為无效能。闭合一條电路指将电路接通之动作而使其運作。而切断一條电路指将电路断开之动作而使其电路異常无法運作，大多數的断路是电线或组件破損而终止电流的流通。

異常 = 断开
abnormal *open*

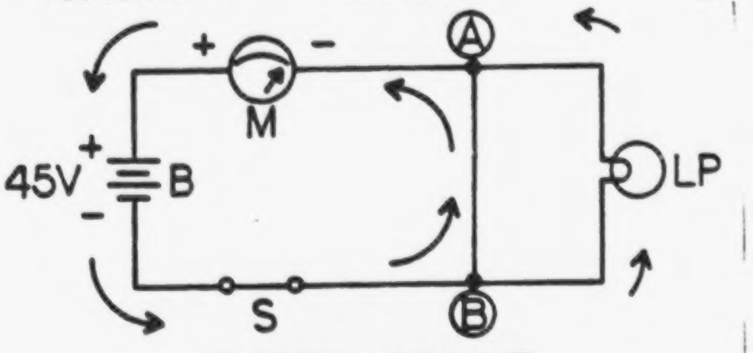


OPEN CIRCUIT

這最後一個概要圖標示出有一條導线在无意中被接在 A, B点之间，因為這是低电阻抗线，因此大量的电流由 A 经此线流至 B. 掠奪了电負荷所須的適量电流。這种现象在技術員的用語是"电流向阻力最小的路线流通"。我们应該知道不是全部电流，但是絕大部份的电流经流此一異常路线，因此使电流有一捷径、即A至B点的线，此異常路徑則称為"短路"(short circuit). 一般講，短路都是不在意或錯誤的接线。一條电电线或一片金屬掉落在电路上都能產生短路。由於短路会產生大量电流通过而燒坏组件或电源。所以必須避免，电路中一段或全段发生短路均是十分危險的。

異常 = 短路

abnormal shorted



SHORT CIRCUIT

總結論：

一个典型的正常电路其能適当地運作以及含有

1. 电源"E"及电流"I" -------- 电供应(supply)
2. 使电路通或断的装置 ------ 电控制器(control)
3. 电流流通的道路 ---------- 導线(conductor)
4. 運作功能的装置 ---------- 电負荷(load)

当电路運作不正確，就被認為異常，共有两种主要類型的现象需经常修護

1. 断路 open circuits
2. 短路 shorted circuits

若你是一位修護員，則常被要求要裝配电器成品。解决毛病的程序稱之為"故障檢修"(troubleshooting)，要檢修速迅則你必須深入了解異常电路的特性。

LII-U11-18

ELECTRONIC C CULUM
VOCATIONAL TRAINING LF PLAN #

Teaching Materials Source ______________________________
Chapter ______________, pages ______________________
Lab Manual pages ______________________
Additional Instructor Materials ______________________________

Main concepts student will learn:

The student will be able to:

1. define the term, symbol, and unit of measurement for resistance, and list the four factors which determine the resistance of wire.
2. name the three common types of resistors and the two coding systems utilized for indicating ohmic values.
3. identify the color coded value of any typical resistor, including the tolerance percentage and mathematically computing the usable tolerance range.

Technical Vocabulary

see
Glossary

Related General Vocabulary

Teaching Activity

In this unit the concept or phrase types of resistors will refer to the resistor's internal composition (carbon, wire wound or film) while the phrase resistor variety is alluding to the physical style (fixed, adjustable, or variable). When presenting this topic, display samples of the components that are available in the shop to help students become more familiar with their physical properties.

Prior to the class presentation on color code ask students to memorize the complete color code system. Select students individually to recite the colors and the number value.

The concept of resistor tolerance and the method of solving specific tolerance ranges are difficult for beginning students to comprehend. Walking the student through some simple problems will improve their understanding and confidence. A review of basic mathematic skills such as percentage determination and decimals can especially assist slower students and is recommended.

Materials and Notes

Make a demonstration display that includes a sample of resistors of various types, color code markings, and physical styles. Cement the parts on a board and label.

Length of Lesson

1 week

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

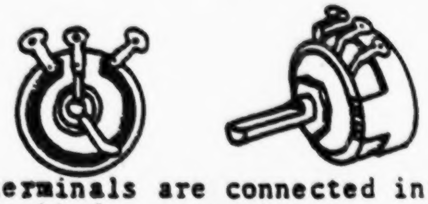
Name: ____________________

Date: ____________________

Period: ____________________

Resistors

TECHNICAL GLOSSARY

ADJUSTABLE RESISTOR:	A wirewound type resistor, with a movable contact. The resistance between the movable terminal and either end of the resistor can be adjusted by sliding the contact across the resistance element. These resistors are made in such a way that frequent adjustment is impractical.
CARBON COMPOSITION RESISTOR:	The most common type of resistor used in electronic devices. It contains carbon as its resistance material, and uses a series of color bands to code its ohmic value.
COLOR CODE:	The resistor color code utilizes a system of three or four color bands, painted around the resistor, to indicate the "ohm value" of the resistor. Each color in the code translates to a number equivalent.
CONDUCTANCE:	The measure of the ability of a wire or circuit to conduct or allow an electric current flow. Conductance is measured in the basic unit mho or siemens. Letter symbol: G.
FILM RESISTOR:	A type of resistor which offers better accuracy and stability than carbon composition resistors. This resistor utilizes a thin layer of carbon, metal, or metallic oxide as its resistance material.
FIXED VALUE RESISTOR:	A resistor which has only one resistance value. Fixed resistors can be either carbon composition, wirewound, or film type.
OHMIC VALUE:	The ohm rating or value of a resistor.
POTENTIOMETER:	A type of variable resistor consisting of resistance material and a movable arm. A terminal is attached to each end of the resistance material and to the movable arm. The output resistance can be set by adjusting the the movable arm. **POT**  When all three of the terminals are connected into a circuit, the device is called a potentiometer. If only the center terminal (arm) and one of the end terminals is used, the device is called a rheostat.
RESISTOR:	An electrical component used to oppose the flow of electrons through a circuit. Resistors are designed to offer a specific resistance or opposition to current, and this resistance is measured in ohms. Symbol: -/\/\/\- Letter symbol: R.

Name: ____________________

Date: ____________________

Period: ____________________

TOLERANCE:	The amount by which the actual value of a component may vary from its marked value and still be considered good. Tolerances are usually expressed as a percentage. For example, the value of a 1000Ω resistor with a 10% tolerance can vary between 900Ω and 1100Ω.
VARIABLE RESISTOR:	A type of resistor built to be easily adjusted to different values. These resistors provide a continuously variable ohmic value over the range of the device. For example, a 1000Ω variable resistor can be adjusted to any value between 0 and 1000 ohms. Potentiometers and rheostats are variable resistors.
WATTAGE RATING:	A measurement of the amount of power that a resistor can handle in relation to its physical size. Excessive power will cause a resistor to overheat and burn-up.
WIRE GAUGE:	A numbering system used to measure the diameter of wire. The American Standard Wire Gauge system utilizes 40 gauge numbers from 0000 to 6. The larger the gauge number, the smaller the wire diameter.
WIREWOUND RESISTOR:	A type of resistor which offers a combination of high accuracy and high power ratings. These resistors are made by winding a special resistance wire on an insulate core.

R =

Resistance

in

Ω's

SCORE:

GRADE:

Name: ________________

Date: ________________

Period: ________________

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Develop a short definition, using your own words, for the following terms. A sketch should be included with your definition when appropriate.

1. COLOR CODE:

2. POTENTIOMETER:

3. RESISTOR:

4. WATTAGE RATING:

5. CARBON COMPOSITION RESISTOR:

6. OHMIC VALUE:

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

RESISTOR COLOR CODING AND DECODING

Determine the resistance value of the following color coded resistors.

EXAMPLE:

First Band	Second Band	Third Band	Fourth Band	
yellow	violet	brown	silver	
4	7	0	±10%	A. 470Ω ±10%

	First Band	Second Band	Third Band	Fourth Band	
1.	Brown ___	Red ___	Brown ___	None ___	1. ☐
2.	Yellow ___	Violet ___	Orange ___	Silver ___	2. ☐
3.	Orange ___	White ___	Red ___	Gold ___	3. ☐
4.	Blue ___	Gray ___	Black ___	None ___	4. ☐
5.	Green ___	Blue ___	Yellow ___	Gold ___	5. ☐
6.	Brown ___	Black ___	Red ___	Silver ___	6. ☐
7.	Gray ___	Red ___	Orange ___	Silver ___	7. ☐
8.	Brown ___	Gray ___	Green ___	None ___	8. ☐

Name: ____________________

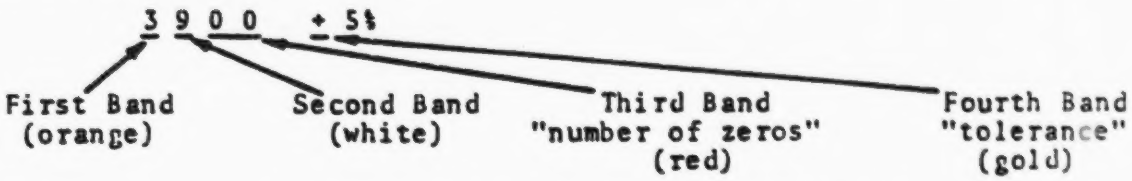
Date: ____________________

Period: ____________________

9. Red ___ Violet ___ Brown ___ Gold ___ 9. ☐

10. Brown ___ Green ___ Blue ___ Silver ___ 10. ☐

Complete the color coding of the following resistors by using the system shown below. This technique can be used when converting a "number value" into a color code equivalent.


3 9 0 0 ± 5%
First Band (orange)
Second Band (white)
Third Band "number of zeros" (red)
Fourth Band "tolerance" (gold)

EXAMPLE:

		1st Band	2nd Band	3rd Band	4th Band		
8.	120Ω ±10%	Brown	______	Brown	Silver	8.	RED
11.	3300Ω ±5%	Orange	Orange	______	Gold	11.	☐
12.	47Ω ±20%	______	Violet	Black	None	12.	☐
13.	680Ω ±10%	Blue	______	Brown	Silver	13.	☐
14.	56000Ω ±10%	______	Blue	Orange	Silver	14.	☐
15.	120000Ω ±5%	Brown	Red	______	Gold	15.	☐
16.	2500Ω ±20%	Red	(A)______	(B)______	None	16A.	☐
						16B.	☐
17.	1000000Ω ±5%	Brown	(A)______	(B)______	(C)______	17A.	☐
						17B.	☐
						17C.	☐

EXTRA CHALLENGE: Try this one:

18. Blue ___ Gray ___ Gold ___ Silver ___ 18. ☐

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

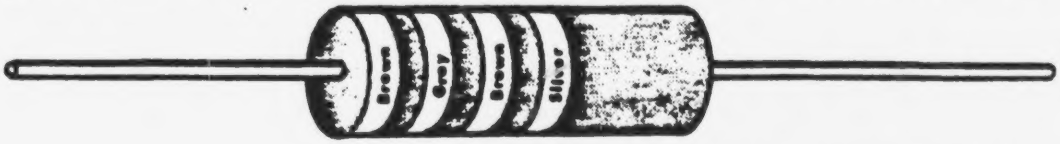
QUEST ACTIVITY

"UNIT 12"

In this activity you will be color coding resistors for an assigned value and computing their tolerance ranges. Cut out the puppets on the attached sheet and use them as the color bands for the blank resistors drawn below. Use colored pencils to shade in each puppet.

EXAMPLE:

A. Color code a 180Ω±10% resistor and determine its tolerance range.



Tolerance range: From 198Ω to 162Ω

Show work:

percentage	upper limit	lower limit
180	180	180
x .10	+ 18	- 18
000		
180	198	162
18.00		

1. Color code a 12000Ω±5% resistor and determine its tolerance range.

Tolerance range: From ____ to ____

Show work:

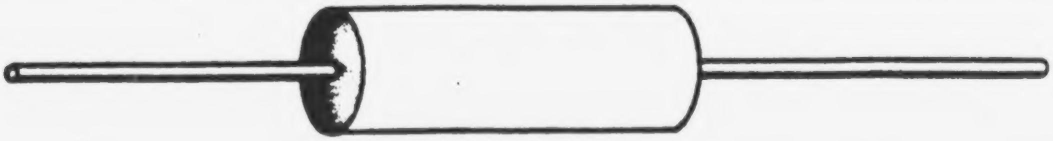
percentage	upper limit	lower limit

Name: ____________________

Date: ____________________

Period: ____________________

2. Color code a $5600\Omega \pm 5\%$ resistor and determine its tolerance range.



Tolerance range: From _____ to _____

Show work:

percentage   upper limit   lower limit

3. Color code a $47\Omega \pm 20\%$ resistor and determine its tolerance range.

Tolerance range: From _____ to _____

Show work:

percentage   upper limit   lower limit

4. Color code a $850000\Omega \pm 10\%$ resistor and determine its tolerance range.

Tolerance range: From _____ to _____

Show work:

percentage   upper limit   lower limit

SPECIAL QUEST:

5. Have your teacher assign you an individual resistance value. Color code that resistor and compute its tolerance range.

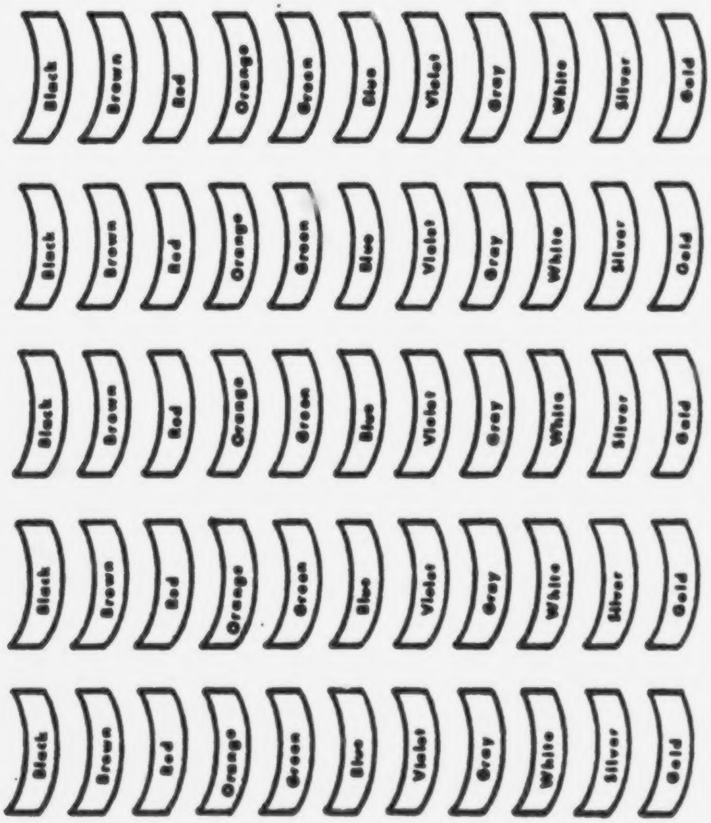
Resistance value: ____________________

Show work: Tolerance range: From _____ to _____

percentage	upper limit	lower limit

CUT

- -


Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold
Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold
Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold
Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold
Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

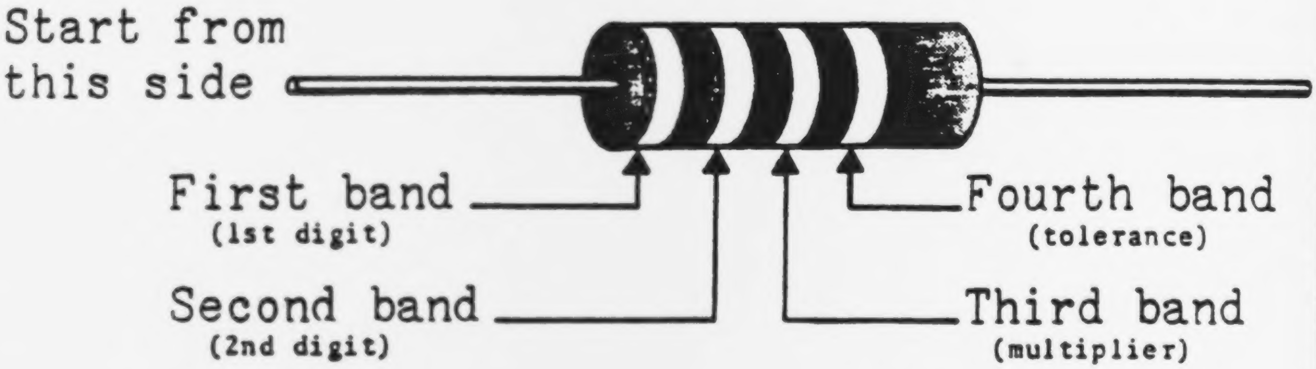
THE RESISTOR COLOR CODE

Carbon composition resistors use a system of three or four color bands painted on the body of the device to indicate its ohmic value. Each color translates into a number or percentage equivalent. Here's how the system works.

Color Code Chart:

	First Color Band	Second Color Band	Third Color Band	Fourth Color Band
Color Code	First Digit	Second Digit	Number of Zeros to Add	Tolerance
0 Black		0	0	No color 20%
1 Brown	1	1	1	Silver 10%
2 Red	2	2	2	Gold 5%
3 Orange	3	3	3	
4 Yellow	4	4	4	
5 Green	5	5	5	
6 Blue	6	6	6	
7 Violet	7	7	7	
8 Gray	8	8		
9 White	9	9		
- Gold	-	-	÷ 10	
- Silver	-	-	÷ 100	

Locating The Color Bands


Start from this side
First band
(1st digit)
Second band
(2nd digit)
Fourth band
(tolerance)
Third band
(multiplier)

Name: ______________________

Date: ______________________

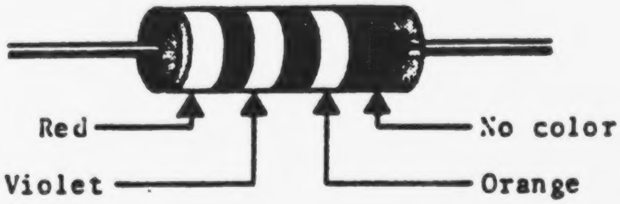
Period: ____________________

Using The Color Code:

Even though it looks a little complicated, using the color code system is actually pretty easy once you have the hang of it. These are the points to remember!!!

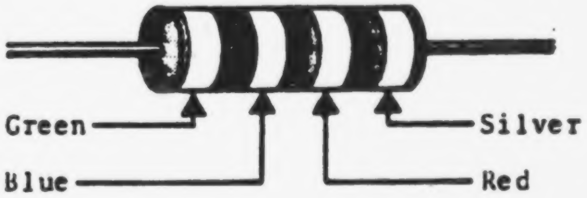
1. The first color band represents the first digit.
2. The second color band represents the second digit.
3. The third color band basically tells how many zeros are added to the first two digits.
4. The fourth color band indicates the ± tolerance.

EXAMPLE:



Red = 2
Violet = 7
Orange = (3)000
No color = ±20%

Total Value 27000Ω ±20%



Green = 5
Blue = 6
Red = (2)00
Silver = ±10%

Total Value 5600Ω ±10%

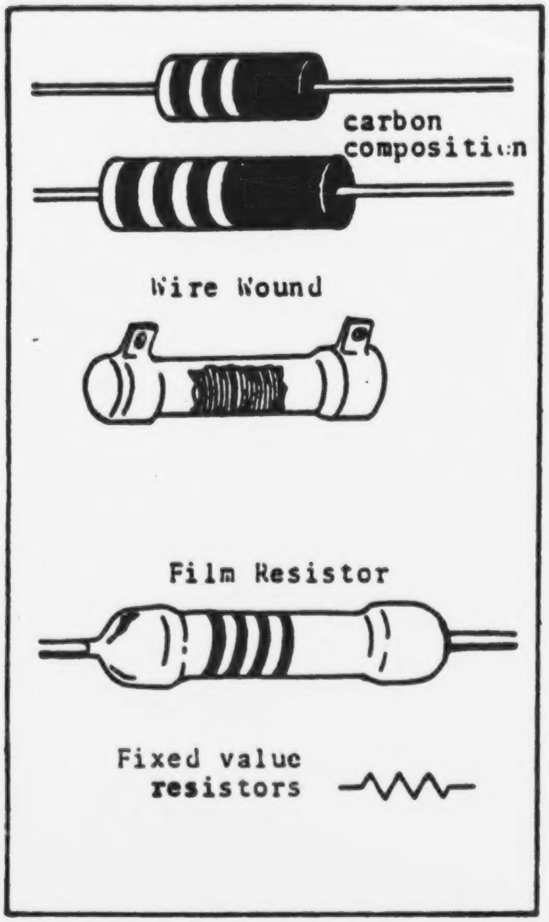
Name: ____________________

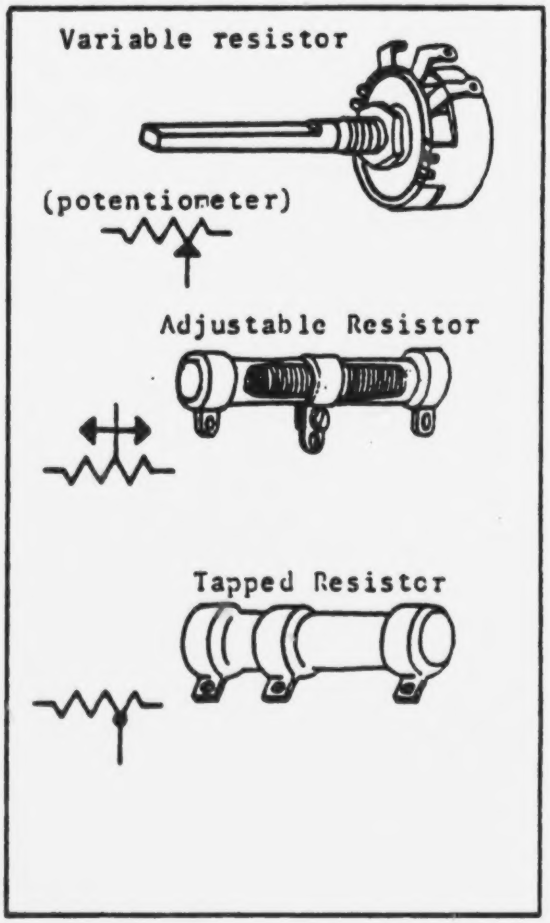
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

RESISTORS - WHAT THEY ARE AND HOW THEY FUNCTION


carbon composition
Wire Wound
Film Resistor
Fixed value resistors


Variable resistor
(potentiometer)
Adjustable Resistor
Tapped Resistor

GENERAL INFORMATION:

- A resistor, as the name implies, offers resistance to the flow of electric current. Most electronic circuits require a number of resistors for such tasks as reducing voltages, limiting currents etc.

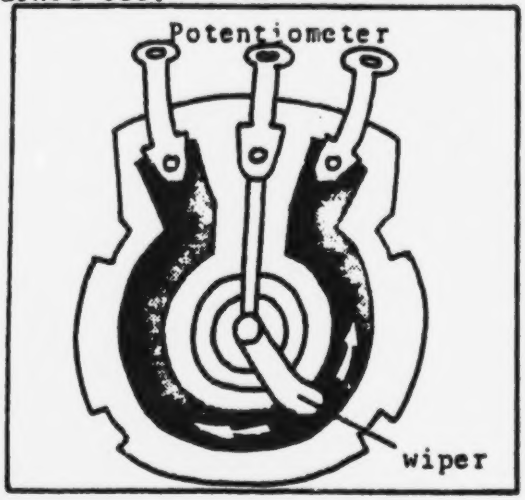
A resistor may be of a fixed, adjustable, or variable value. The terms "potentiometer", "rheostat", and "volume control" are often used interchangeably to describe variable style resistors, but they are not the same thing. A potentiometer or rheostat is a device whose value can be varied mechanically, such as by turning a shaft or moving a slider. A potentiometer is a three terminal variable resistor with connections at both ends and to a center moving contact, while a rheostat is a two terminal variable resistor with a connection to a moving slider, and only one end. Study the diagram on page - 18, it describes the internal connections of both devices. A volume control is a potentiometer used in a specific application

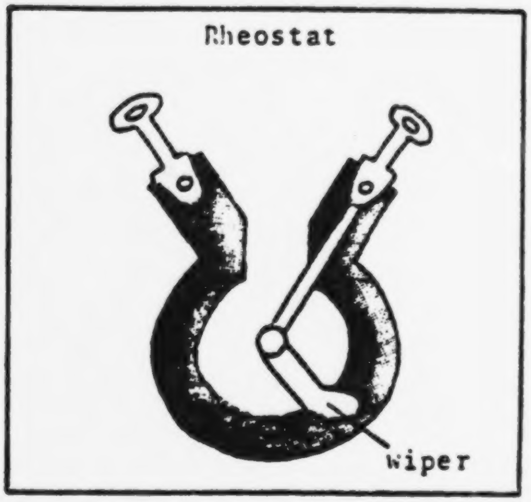
Name: ____________________

Date: ____________________

Period: __________________

- When connecting fixed value resistors into a circuit you need not worry about polarity. Thus, a resistor may be oriented in either direction in the circuit. Also be aware that resistors produce heat while operating. Many wirewound resistors will produce enough heat to cause serious burns, so be cautious when handling resistors in a circuit that has recently been turned off.





- Resistors are made in three basic types; carbon composition, wire wound, and film. These same materials can be used to construct either fixed value or variable style resistors in a large number of ohmic values.

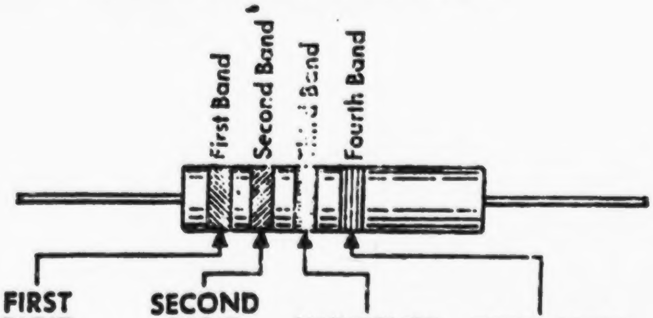
- All resistors have three important specifications:

VALUE: Given in ohms, kilo ohms (kΩ - thousands of ohms), and megohms (MΩ - millions of ohms). The word ohm is often represented by the Greek letter omega - (Ω).

WATTAGE: Specified in watts or fractions of a watt. This is the amount of electrical power the resistor can safely dissipate as heat.

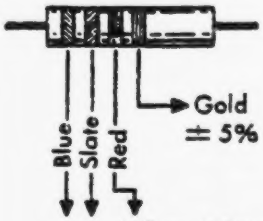
TOLERANCE: Given as a percentage figure, indicates the possible variation in a resistor's actual value from its "normal" rated value. For example, a 1000 ohm, 10% resistor may have an actual value somewhere between 900 and 1100 ohms.

RESISTOR COLOR CODE

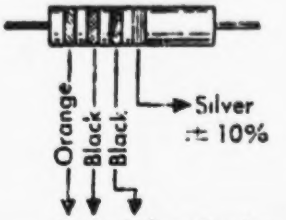

First Band
Second Band
Third Band
Fourth Band

COLOR	FIRST DIGIT	SECOND DIGIT	MULTIPLIER	TOLERANCE	COLOR
Black	0	0	10^0	—	Black
Brown	1	1	10^1	—	Brown
Red	2	2	10^2	—	Red
Orange	3	3	10^3	—	Orange
Yellow	4	4	10^4	—	Yellow
Green	5	5	10^5	—	Green
Blue	6	6	10^6	—	Blue
Violet	7	7	—	—	Violet
Slate	8	8	—	—	Slate
White	9	9	—	—	White
Silver	—	—	10^{-2}	± 10%	Silver
Gold	—	—	10^{-1}	± 5%	Gold
No Color	—	—	—	± 20%	No Color

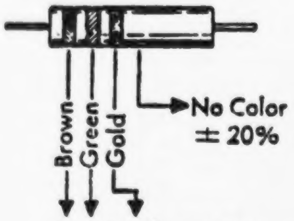
EXAMPLES:


Blue
Slate
Red
Gold
± 5%

$6 \; 8 \times 10^2 = 6800$ ohms


Orange
Black
Black
Silver
± 10%

$3 \; 0 \times 10^0 = 30$ ohms

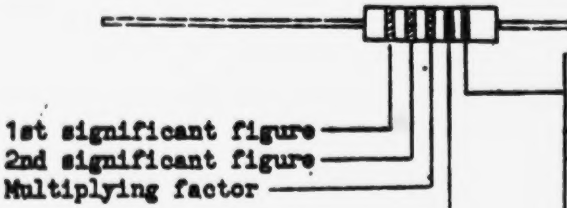

Brown
Green
Gold
No Color
± 20%

$1 \; 5 \times 10^{-1} = 1.5$ ohms

FIVE BAND RESISTOR COLOR CODING

Five-stripe resistors are seen more often in industry today... BUT seldom seen in our textbooks. Here are three different types of five band coding now in use. The first two methods are less often seen than the third method shown below.

I. COMPOSITION


1st significant figure
2nd significant figure
Multiplying factor

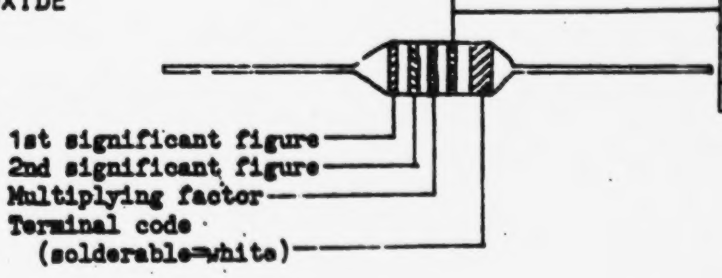
RELIABILITY

Failure rate level, %/1000 hours

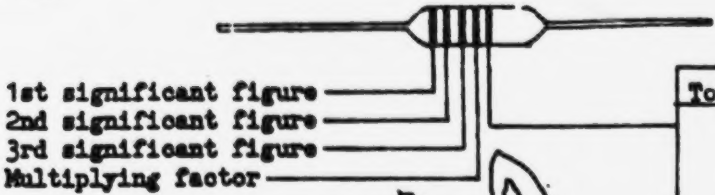
COLOR	LEVEL
brown	M= 1.0%
red	P= 0.1%
orange	R= 0.01%
yellow	S= 0.001%

II. METAL OXIDE

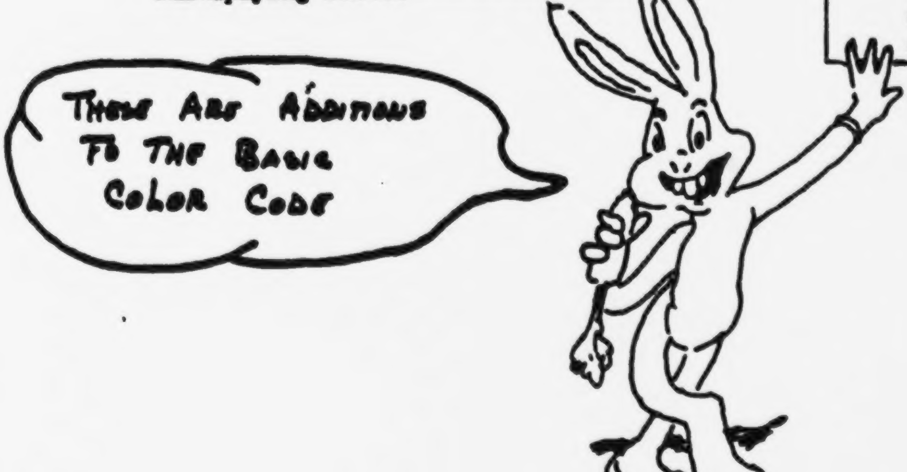
Tolerance	Code
± 2%	red
5%	gold
10%	silver

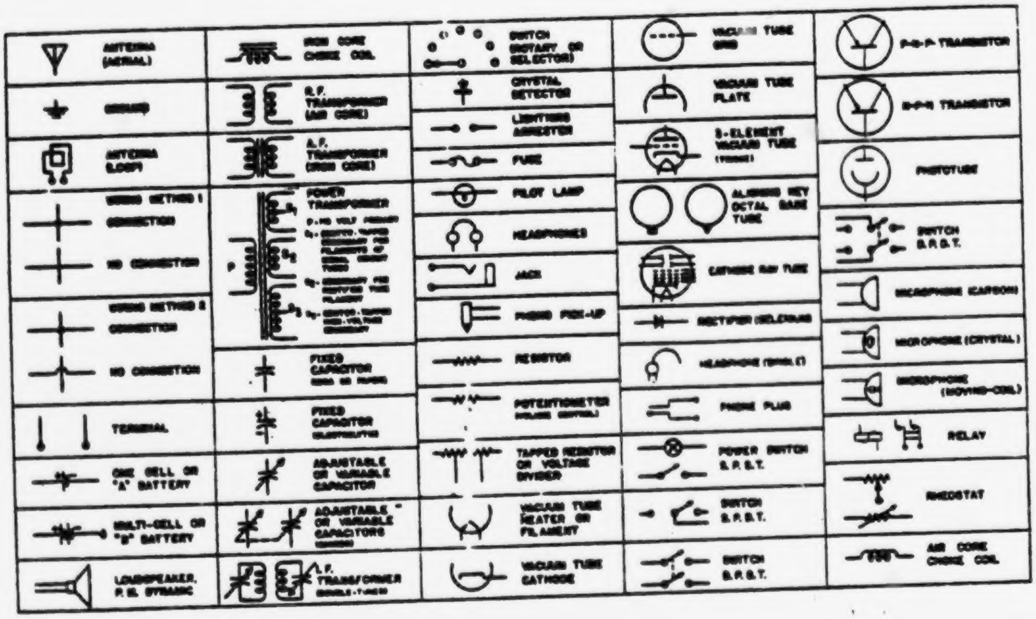

1st significant figure
2nd significant figure
Multiplying factor
Terminal code
(solderable=white)

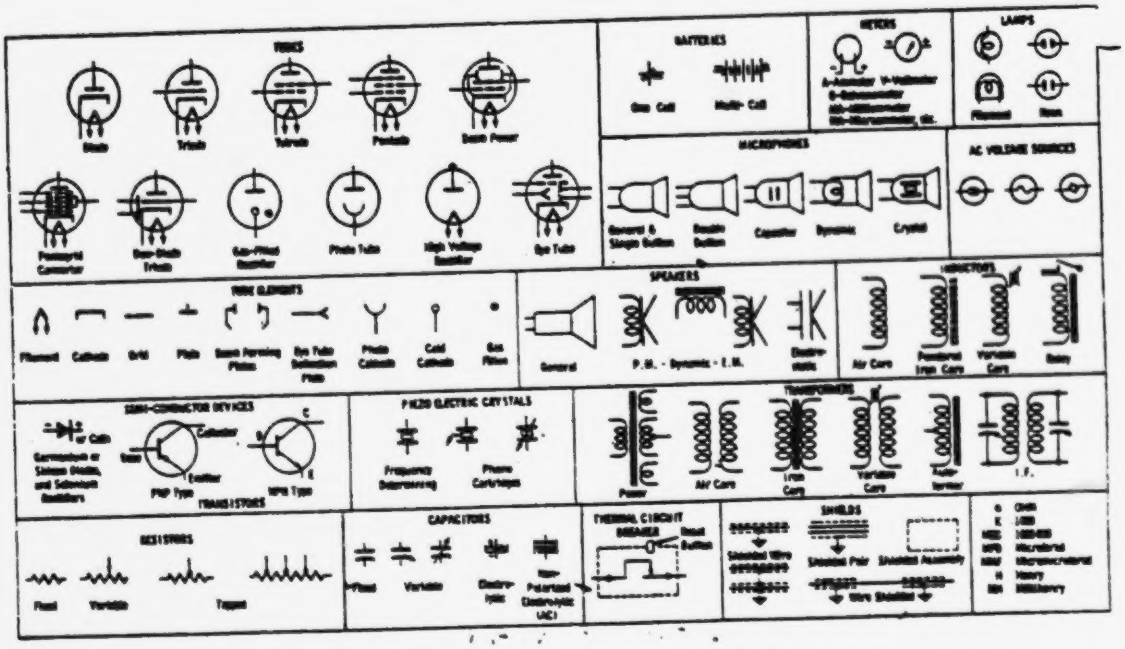
III. METAL FILM


1st significant figure
2nd significant figure
3rd significant figure
Multiplying factor

Tolerance	Code
± 1%	brown
0.5%	green
0.25%	blue
0.10%	violet
0.05% (wow!)	gray

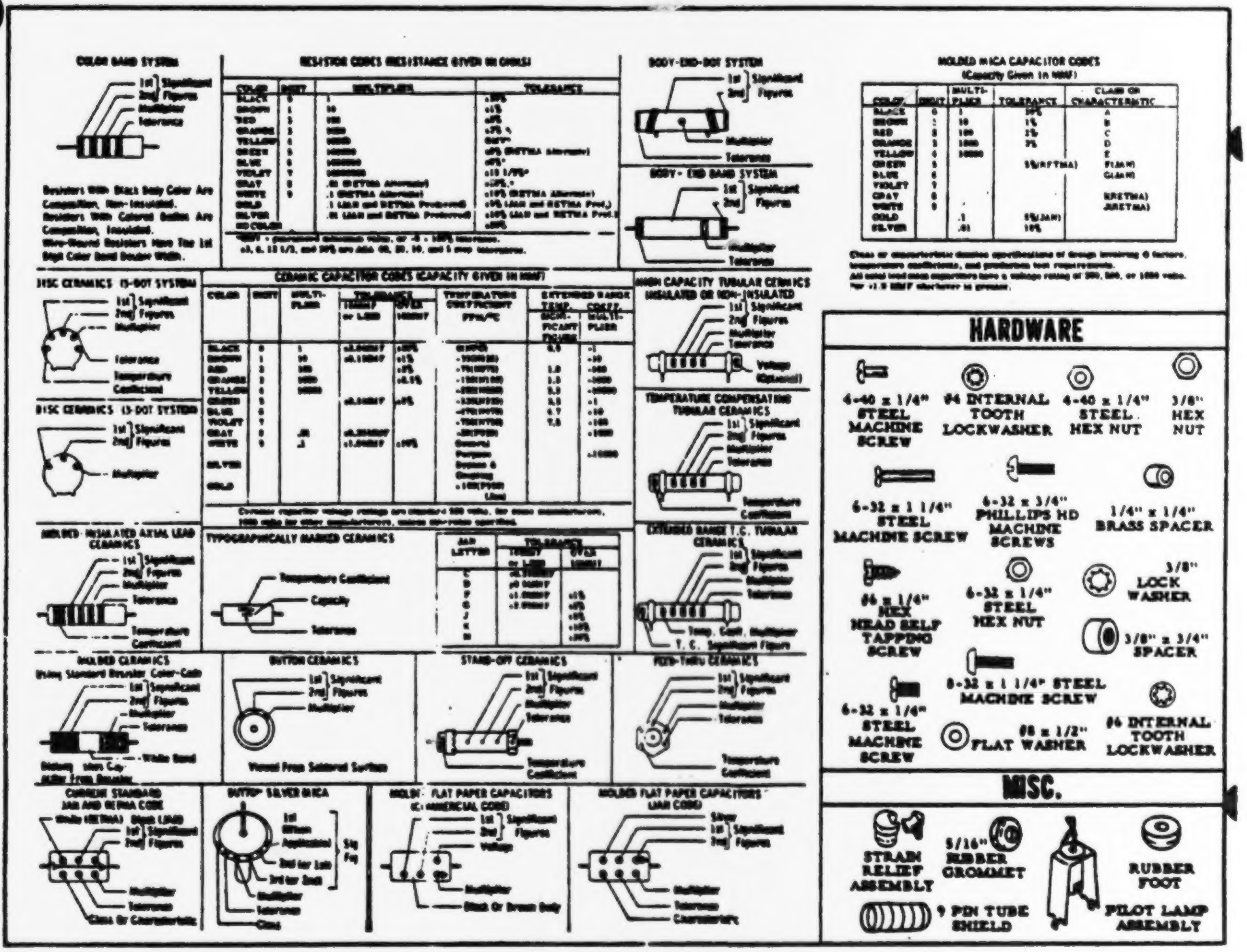

THESE ARE ADDITIONS TO THE BASIC COLOR CODE


ANTENNA (AERIAL)
GROUND
ANTENNA (LOOP)
WIRING METHOD 1
CONNECTION
NO CONNECTION
WIRING METHOD 2
CONNECTION
NO CONNECTION
TERMINAL
ONE CELL OR "A" BATTERY
MULTI-CELL OR "B" BATTERY
LOUDSPEAKER, P.M. DYNAMIC
IRON CORE CHOKE COIL
R.F. TRANSFORMER (AIR CORE)
A.F. TRANSFORMER (IRON CORE)
POWER TRANSFORMER
P-110 VOLT PRIMARY
S1-CENTER-TAPPED SECONDARY FOR FILAMENTS OF POWER OUTPUT TUBES
S2-SECONDARY FOR RECTIFIER TUBE FILAMENT
S3-CENTER-TAPPED HIGH-VOLTAGE SECONDARY
FIXED CAPACITOR (MICA OR PAPER)
FIXED CAPACITOR (ELECTROLYTIC)
ADJUSTABLE OR VARIABLE CAPACITOR
ADJUSTABLE OR VARIABLE CAPACITORS (GANGED)
I.F. TRANSFORMER (DOUBLE-TUNED)
SWITCH (ROTARY OR SELECTOR)
CRYSTAL DETECTOR
LIGHTNING ARRESTER
FUSE
PILOT LAMP
HEADPHONES
JACK
PHONO PICK-UP
RESISTOR
POTENTIOMETER (VOLUME CONTROL)
TAPPED RESISTOR OR VOLTAGE DIVIDER
VACUUM TUBE HEATER OR FILAMENT
VACUUM TUBE CATHODE
VACUUM TUBE GRID
VACUUM TUBE PLATE
3-ELEMENT VACUUM TUBE (TRIODE)
ALIGNING KEY OCTAL BASE TUBE
CATHODE RAY TUBE
RECTIFIER (SELENIUM)
HEADPHONE (SINGLE)
PHONE PLUG
POWER SWITCH S.P.S.T.
SWITCH S.P.D.T.
SWITCH D.P.S.T.
P-N-P TRANSISTOR
N-P-N TRANSISTOR
PHOTOTUBE
SWITCH D.P.D.T.
MICROPHONE (CARBON)
MICROPHONE (CRYSTAL)
MICROPHONE (MOVING-COIL)
RELAY
RHEOSTAT
AIR CORE CHOKE COIL


TUBES
Diode
Triode
Tetrode
Pentode
Beam Power
Pentagrid Converter
Duo-Diode Triode
Gas-Filled Rectifier
Photo Tube
High Voltage Rectifier
Eye Tube
BATTERIES
One Cell
Multi-Cell
METERS
A-Ammeter V-Voltmeter
G-Galvanometer
MA-Milliammeter
MA-Microammeter, etc.
LAMPS
Filament
Neon
MICROPHONES
General & Single Button
Double Button
Capacitor
Dynamic
Crystal
AC VOLTAGE SOURCES
TUBE ELEMENTS
Filament
Cathode
Grid
Plate
Beam Forming Plates
Eye Tube Deflection Plate
Photo Cathode
Cold Cathode
Gas Filled
SPEAKERS
General
P.M. - Dynamic - E.M.
Electro-static
INDUCTORS
Air Core
Powdered Iron Core
Variable Core
SEMI-CONDUCTOR DEVICES
or Cath
Germanium or Silicon Diodes, and Selenium Rectifiers
Base
Collector
Emitter
PNP Type
C
B
E
NPN Type
TRANSISTORS
PIEZO ELECTRIC CRYSTALS
Frequency Determining
Phono Cartridges
TRANSFORMERS
Power
Air Core
Iron Core
Variable Core
Auto-former
I.F.
RESISTORS
Fixed
Variable
Tapped
CAPACITORS
Fixed
Variable
Electro-lytic
Non-Polarized Electrolytic (AC)
THERMAL CIRCUIT BREAKER
Reset Button
SHIELDS
Shielded Wire
Shielded Pair
Shielded Assembly
Wire Shielded
Ω Ohm
K 1000
MEG 1,000,000
MFD Microfarad
MMF Micromicrofarad
H Henry
MH Millihenry

BEST COPY AVAILABLE

Resistor-Capacitor Color Code


COLOR BAND SYSTEM
RESISTOR CODES (RESISTANCE GIVEN IN OHMS)
BODY-END-DOT SYSTEM
BODY-END BAND SYSTEM
MOLDED MICA CAPACITOR CODES
DISC CERAMICS 5-DOT SYSTEM
CERAMIC CAPACITOR CODES (CAPACITY GIVEN IN MMF)
HIGH CAPACITY TUBULAR CERAMICS
DISC CERAMICS 3-DOT SYSTEM
TEMPERATURE COMPENSATING TUBULAR CERAMICS
MOLDED INSULATED AXIAL LEAD CERAMICS
TYPOGRAPHICALLY MARKED CERAMICS
EXTENDED RANGE T.C. TUBULAR CERAMICS
MOLDED CERAMICS
BUTTON CERAMICS
STAND-OFF CERAMICS
FEED-THRU CERAMICS
Viewed From Soldered Surface
BUTTON SILVER MICA
MOLDED FLAT PAPER CAPACITORS
1st
2nd
Significant
Figures
Multiplier
Tolerance
Temperature Coefficient
HARDWARE
4-40 x 1/4" STEEL MACHINE SCREW
#4 INTERNAL TOOTH LOCKWASHER
4-40 x 1/4" STEEL HEX NUT
3/8" HEX NUT
6-32 x 1 1/4" STEEL MACHINE SCREW
6-32 x 3/4" PHILLIPS HD MACHINE SCREWS
1/4" x 1/4" BRASS SPACER
#6 x 1/4" HEX HEAD SELF TAPPING SCREW
6-32 x 1/4" STEEL HEX NUT
3/8" LOCK WASHER
3/8" x 3/4" SPACER
8-32 x 1 1/4" STEEL MACHINE SCREW
6-32 x 1/4" STEEL MACHINE SCREW
#8 x 1/2" FLAT WASHER
#6 INTERNAL TOOTH LOCKWASHER
MISC.
STRAIN RELIEF ASSEMBLY
5/16" RUBBER GROMMET
RUBBER FOOT
9 PIN TUBE SHIELD
PILOT LAMP ASSEMBLY

BEST COPY AVAILABLE

Name: ____________________

Date: ____________________

Period: ____________________

7. FILM RESISTOR:

8. TOLERANCE:

9. WIRE GAUGE:

10. WIRE WOUND RESISTOR:

11. CONDUCTANCE:

12. ADJUSTABLE RESISTOR:

RESISTORS: Fixed and Variable

Lab Sheet #5

OBJECTIVES

To learn to read the resistor color code
To learn to identify and measure fixed and variable resistors
To learn what a Thermistor and CdS cell are, and what they do

MATERIALS

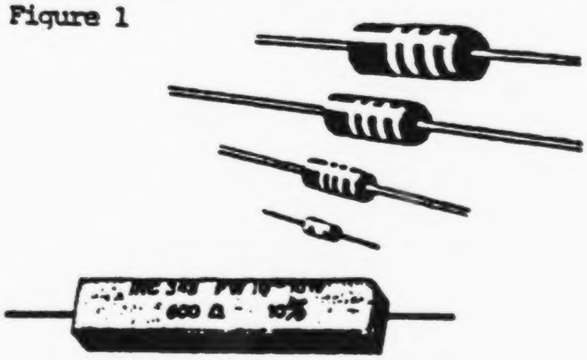
VTVM (Check out from tool room)
Potentiometer Board, called a "Pot Board" (Check out from tool room)
DMM
Solderless Breadboard (purchased as personal equipment)

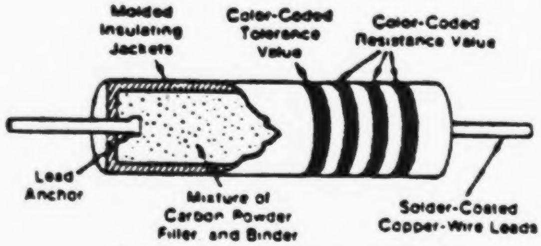
INTRODUCTION

The resistance value of a carbon resistor is usually indicated on the resistor body using color coded bands. Learn the color code as soon as possible. It will be very helpful to you. Refer to your textbook for the method of reading the resistor color code. Also, read the chapter on resistors.

Shown below are some typical resistor types that you will encounter while studying and working in electronics.

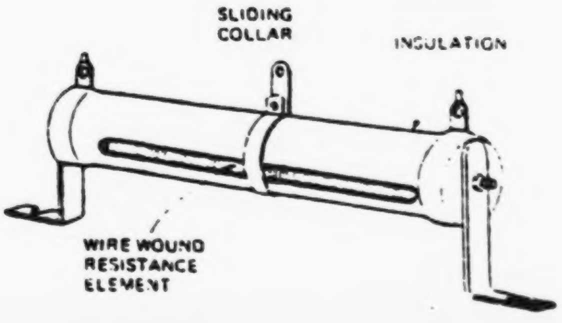
Figure 1



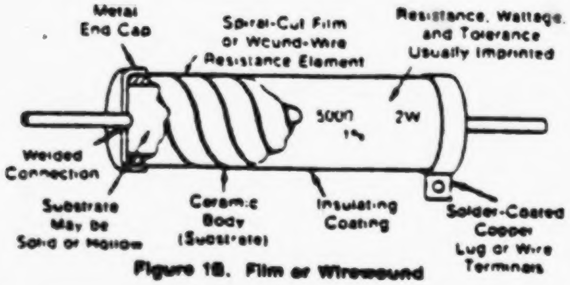


Molded Insulating Jackets
Color-Coded Tolerance Value
Color-Coded Resistance Value
Lead Anchor
Mixture of Carbon Powder Filler and Binder
Solder-Coated Copper-Wire Leads

Figure 1A. Carbon Composition



SLIDING COLLAR
INSULATION
WIRE WOUND RESISTANCE ELEMENT



Metal End Cap
Spiral-Cut Film or Wound-Wire Resistance Element
Resistance, Wattage, and Tolerance Usually Imprinted
500Ω
1%
2W
Welded Connection
Substrate May be Solid or Hollow
Ceramic Body (Substrate)
Insulating Coating
Solder-Coated Copper Lug or Wire Terminals

Figure 1B. Film or Wirewound Resistor Construction

PROJECT 1: Becoming Familiar with Your Solderless Breadboard

INTRODUCTION

You will be using a solderless breadboard in every lab course during your electronics training program. If you have not purchased one yet you must do so as soon as possible. NOTE: These solderless breadboards sometimes are called "SUPER STRIP", "PRONTOBOARD", or "EXPERIMENTER SOCKET", which are trade mark names by different manufacturers.

Shown in Figure 1 is a typical solderless breadboard. There are different types and sizes for different applications. The type shown here is adequate for all your needs in this training program. You should become familiar with your solderless breadboard and be sure that you understand which contacts are connected to each other.

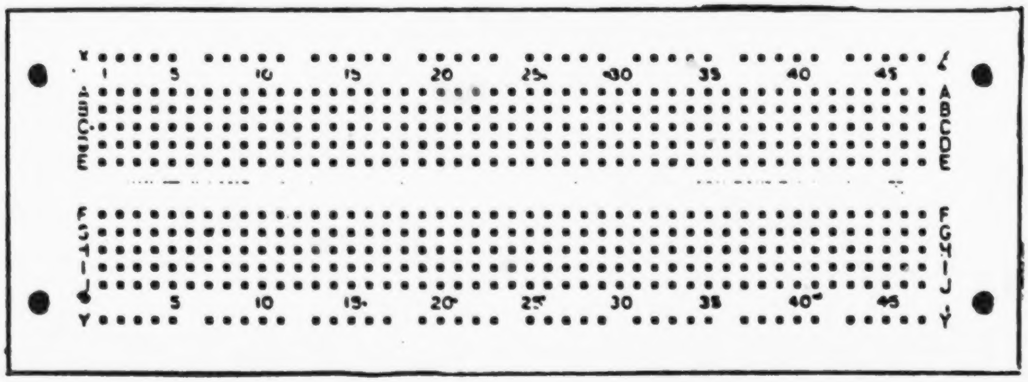


Figure 1

Although there are different types of solderless breadboards, the type you probably will get is connected like this:

a. There are 5 holes, with contacts inside, which are aligned vertically. These 5 points will be connected to each other but to nothing else. Each column of 5 contacts is numbered from 1 to 47.

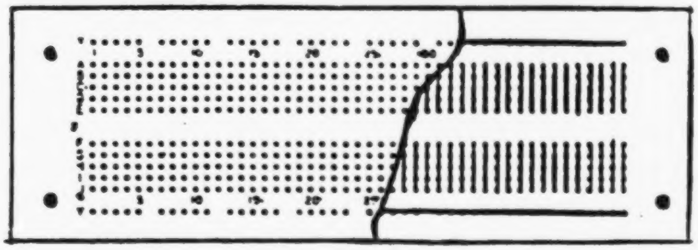
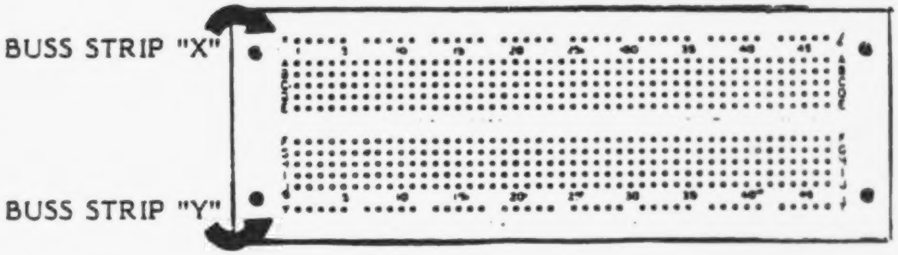


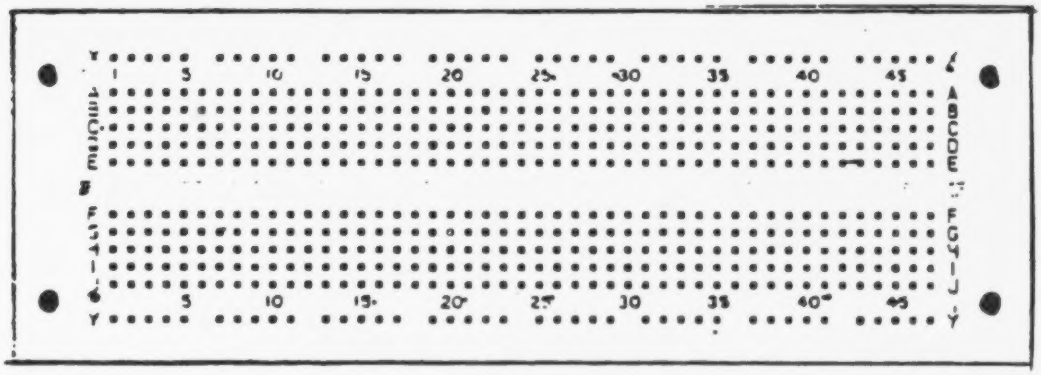
Figure 2

b. There is a horizontal row of holes, with contacts, running across the top and bottom of the breadboard. The top one is labeled "X" and the bottom one is labeled "Y". All contacts in each row are interconnected from one end of the board to the other. Each of these rows of contacts are called a "buss strip". The top buss strip usually is for "+" voltage and the bottom buss strip is for "-" voltage or "ground". Figure 2 is a cutaway view of one type of solderless breadboard showing the interconnections.



INSTRUCTIONS

1. On the drawing below, draw lines through all vertical contacts which are interconnected. Use an ohmmeter to determine the interconnections. Poke one end of a resistor lead in the hole for your ohmmeter to make contact.
NOTE: If your solderless breadboard is different than the drawing below, make a sketch of your own board and mark how the contacts are connected.



2. Check the horizontal "X" and "Y" rows with the ohmmeter in the same way. Some breadboards are made with the buss strip interconnected from one end to the other. Some are made with only groups of 5 contacts interconnected. Check yours carefully.

3. Do you understand how each contact is connected on your solderless breadboard? YES/NO

PROJECT 2: Checking the Resistors in Your Parts Kit

INTRODUCTION

You must purchase a Parts Kit which you will use throughout this course. In this Project you will check the resistors in the kit and become familiar with the resistor color code.

In this Project you must read the resistor color code. Refer to your textbook for help. HINT: Look in the index under "Resistor color code". You may find it difficult at first to identify the exact color of some resistors. With practice it will become easier. For now, guess. You will be checking the exact value later with the ohmmeter. You can change your "guess" later.

INSTRUCTIONS

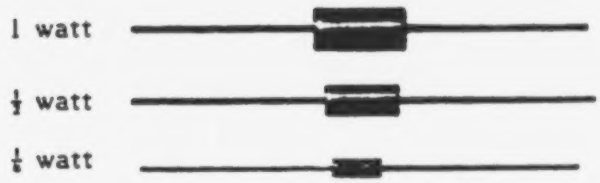
1. Lay out all the resistors from your kit so you can read the color code.

2. Read the color code for the ohmic value of each resistor. Record the color coded value in TABLE 1 under "Coded Value" (column 1). Arrange the resistors by ohmic value so the lowest value is listed as "R1" in TABLE 1.

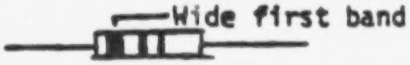
3. Read the % tolerance (4th band) and record in TABLE 1, column 2.

4. Note the physical size of each resistor and determine the wattage rating by comparing it to the drawing below. Record the wattage rating in TABLE 1, column 3. (Hint: Most of the resistors in your kit are 1/2 watt size.)

NOTE: Most resistors are carbon composition or film type.
A wirewound type is common also. It has a wide first band of the color code bands.



CARBON COMPOSITION



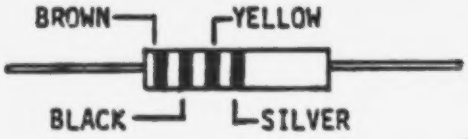
WIREWOUND

NOTE: The next step can be hazardous to the meters if you do not do it properly. You will be measuring first with the VTVM ohmmeter and then with the DMM ohmmeter. DO NOT PLACE BOTH OHMMETERS ON THE SAME RESISTOR AT THE SAME TIME. Use only one ohmmeter on a resistor at a time.

5. Measure the resistance of each resistor first with the VTVM and then with the DMM. Record your measurements in TABLE 1, column 5.

6. In this step, you will calculate the minimum and maximum ohmic value acceptable for each resistor. Since resistors are not exactly the value coded, there is a LOW LIMIT and a HIGH LIMIT which can still be within the acceptable tolerance. You must now calculate the LOW LIMIT and HIGH LIMIT resistance for each resistor. Use the data in TABLE 1, column 1 and column 2, and the example below. Record in TABLE 1, column 4.

Example:



BROWN= 1
BLACK= 0
YELLOW= 4 zeroes.
Therefore resistance
is 100000 ohms.

SILVER= ± 10%

Formula for TOLERANCE VALUE, HIGH LIMIT, and LOW LIMIT:

TOLERANCE VALUE = (Color coded value) x (% Tolerance)

LOW LIMIT = (Color coded value) - (TOLERANCE VALUE)

HIGH LIMIT = (Color coded value) + (TOLERANCE VALUE)

Example:

Color coded value: 100,000 ohms (Brown/Black/Yellow)

Tolerance %: 10% (Brown/Black/Yellow/Silver)

TOLERANCE VALUE = (100,000) x (.10) = 10,000 ohms

LOW LIMIT = (100,000) - (10,000) = 90,000 ohms

HIGH LIMIT = (100,000) + (10,000) = 110,000 ohms

7. Compare your results for all resistors with your lab partner. Check any differences to determine why they are different. Complete TABLE 1, column 6.

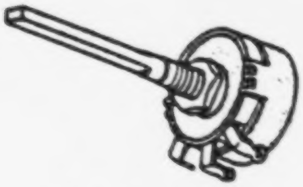
NOTE: You may find some resistors which measure more or less than the low and high limit. Unless the resistor is more than 20% out of tolerance, use it throughout these Projects. Later in the semester, if you need more accurate resistors, you can check out a Resistor Decade Box or the Precision Resistor Board.

PROJECT 3: Checking Variable Resistors

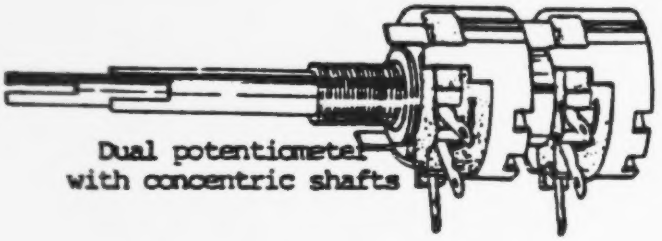
INTRODUCTION

There are two main classes of resistors: (1) fixed, which always have the same resistance, and (2) variable, in which the resistance can be changed. So far you have been working only with fixed resistors. Now you will start working with variable resistors.

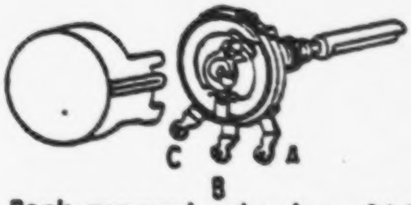
One of the most common types of variable resistors is the POTENTIOMETER. It is often referred to as a "Pot". Your radio volume control is a potentiometer. Shown below are some potentiometers and the schematic drawing. Pay particular attention to the center contact(B). It connects to a movable slider or arm which rotates by the shaft. As the shaft is rotated, the position of the slider varies between terminals A and C. Therefore, the resistance is varied between A and B, as well as between B and C. The resistance between A and C always remains constant. While doing this Project be sure to learn and understand how the potentiometer works.



Potentiometer



Dual potentiometer with concentric shafts



Back removed, showing slider

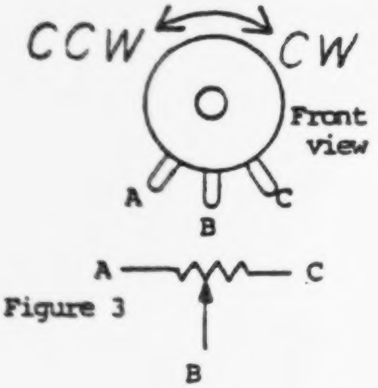


Figure 3

INSTRUCTIONS

1. Locate the "Pot Board" and select any one of the potentiometers for this Project. Identify the two end terminals of the potentiometer indicated above as points A and C. Measure the resistance between A and C with the VTVM ohmmeter. Call this resistance R_{AC} and record it in TABLE 2.

NOTE: If you measure 10kohms from A to C, then this is a 10kohms potentiometer. It will usually be simply called a "10 k Pot".

The potentiometer you selected is a "____ __ Pot".

2. Connect the VTVM ohmmeter to terminals A and B. Rotate the shaft until you measure 0 ohms. (NOTE: This should be full rotation counterclockwise and it may not go down to exactly 0 ohms.) Call this resistance R_{AB}.

Record R_{AB}: _______ ohms.

3. Rotate the shaft approximately 1/4 turn clockwise. What is the resistance R_{AB} now?

R_{AB}: _______ ohms.

4. Rotate the shaft approximately 1/2 turn clockwise. What is the resistance R_{AB} now?

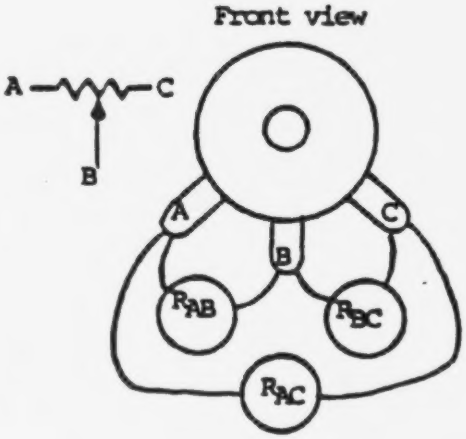
R_{AB}: _______ ohms.

5. Rotate the shaft approximately 3/4 turn clockwise. What is the resistance R_{AB} now?

R_{AB}: _______ ohms.

6. Rotate the shaft fully clockwise. What is the resistance R_{AB} now?

R_{AB}: _______ ohms.



7. Complete the statements below based on what you observed. Cross out all incorrect words.

a. As the shaft was rotated clockwise, the resistance (increased) (decreased) (remained the same).

b. As the shaft was rotated clockwise, the slider moved (closer to) (farther from) terminal A.

c. As the shaft was rotated clockwise, the slider moved (closer to) (farther from) terminal C.

d. By rotating the shaft, the potentiometer can be adjusted to any value between 0 ohms and (the full rating of the pot) (27,000 ohms) (infinity).

8. Now connect the VTVM ohmmeter to terminals B and C on the potentiometer. Rotate the shaft fully counterclockwise and measure the resistance R_{BC}.

Record R_{BC}: _______ ohms.

9. Rotate the shaft approximately 1/4 turn clockwise. What is the resistance R_{BC} now?

R_{BC}: _______ ohms.

10. Rotate the shaft approximately 1/2 turn clockwise. What is the resistance R_{BC} now?

R_{BC}: ________ohms.

11. Rotate the shaft approximately 3/4 turn clockwise. What is the resistance R_{BC} now?

R_{BC}: ________ohms.

12. Rotate the shaft fully clockwise. What is the resistance R_{BC} now?

R_{BC}: ________ohms.

13. Complete the statements below based on what you observed. Cross out all incorrect words.

a. As the shaft was rotated clockwise, the resistance (increased) (decreased) (remained the same).

b. As the shaft was rotated clockwise, the slider moved (closer to) (farther from) terminal A.

c. As the shaft was rotated clockwise, the slider moved (closer to) (farther from) terminal C.

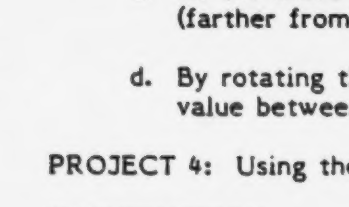
d. By rotating the shaft, the potentiometer can be adjusted to any value between 0 ohms and (the full rating of the pot) (infinity)

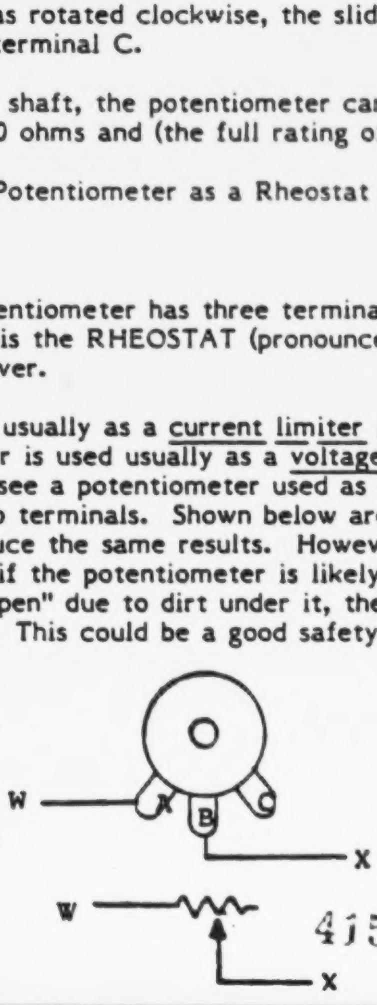
PROJECT 4: Using the Potentiometer as a Rheostat

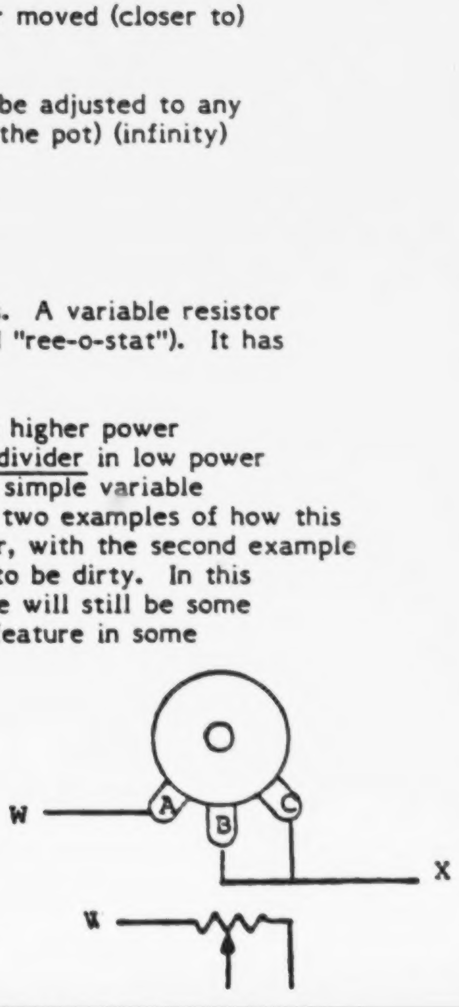
INTRODUCTION

Notice that the potentiometer has three terminals. A variable resistor that resembles the "pot" is the RHEOSTAT (pronounced "ree-o-stat"). It has only two terminals, however.

The rheostat is used usually as a current limiter in higher power circuits. A potentiometer is used usually as a voltage divider in low power circuits. Often you will see a potentiometer used as a simple variable resistor by using only two terminals. Shown below are two examples of how this may be done. Both produce the same results. However, with the second example there is some advantage if the potentiometer is likely to be dirty. In this case, should the slider "open" due to dirt under it, there will still be some resistance in the circuit. This could be a good safety feature in some circuits.

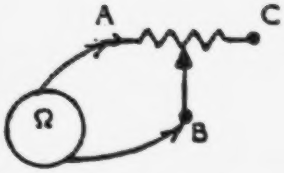




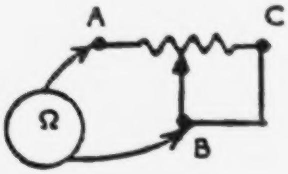


INSTRUCTIONS

1. Connect the DMM ohmmeter to terminals A and B of the same potentiometer used in PROJECT 2. Set the resistance, R_{AB}, for approximately one-half the full value of the "pot".



2. Leave the ohmmeter connected, and connect a clip lead between terminals B and C.



Did the resistance change? YES/NO (It should not)

3. Experiment with this "pot" which is connected for use as a rheostat. You should see that it operates exactly the same as the "pot" R_{AB}. However, should there be dirt under the slider, the circuit will not completely "open". There will be at least the total resistance of the "pot" still in the circuit. This is not very important right now, except that you will be seeing "pots" used both ways in circuits and may wonder what the difference is. In some circuits, this simple extra connection can prevent component damage.

PROJECT 5: Experimenting with a Temperature Sensitive Resistor

INTRODUCTION

A THERMISTOR (THERMally sensitive resISTOR) is made out of semiconductor material. It has resistance which varies as temperature changes. Thermistors can be made so that the resistance goes up as temperature goes up. These have a POSITIVE TEMPERATURE COEFFICIENT. Other thermistors can be made so that the resistance goes down as temperature goes up. These have a NEGATIVE TEMPERATURE COEFFICIENT. Thermistors are used in many applications such as remote measurement of temperature and automatic controls.

In this Project, you will be observing how the resistance of a thermistor changes with temperature changes.

INSTRUCTIONS

1. Using the DMM ohmmeter, measure the resistance of the thermistor at room temperature. This will be called the "cold resistance". Record.

Cold resistance: ____________ ohms.

2. Warm the thermistor with your fingers while monitoring the resistance with the DMM. You need only heat it enough to see that resistance does change with heat. Make sure you do not measure the resistance of your fingers instead of the thermistor (keep your fingers off the leads!). Record the "warm resistance".

Warm resistance: ____________ohms.

Does temperature change the thermistor resistance? YES/NO

This thermistor has a temperature coefficient which is: POSITIVE/NEGATIVE.

PROJECT 6: Experimenting with a Light Sensitive Resistor

INTRODUCTION

Photoconductive cells are made of material which passes current more easily as light is increased. That is, resistance goes down as light increases. Therefore, photoconductive cells have a negative coefficient.

Two materials in common use for making photoconductive cells are cadmium Sulfide(CdS) and Cadmium Selenide(CdSe). You will be using a photoconductive cell made of Cadmium Sulphide.

Incidentally, do not confuse a photoconductive cell with a photovoltaic cell (commonly called a "solar cell"). The photovoltaic cell PRODUCES a voltage and current with light. A photoconductive cell CHANGES resistance with light.

INSTRUCTIONS

1. Using the DMM ohmmeter, measure the DARK RESISTANCE of the CdS cell by covering it with your hand. Notice that your finger may not block out all light. Record.

Dark resistance: _________ohms.

2. Expose the CdS cell to room light and measure the LIGHT RESISTANCE. Record.

Light resistance: ________ohms.

3. Did the resistance change as light changed? YES/NO

The resistance of the CdS cell decreased as light INCREASED/DECREASED.

PROJECT 7: Self Evaluation Quiz

INSTRUCTIONS

Do these questions at home to make most effective use of your lab time. Go directly to the next Lab Sheet now.

Complete the statements by selecting the correct words. Be sure that you have read your textbook before doing the Projects and this quiz.

1. Turning the potentiometer clockwise will cause the resistance between terminals A and B to (increase) (decrease) (remain the same).

2. Turning the potentiometer clockwise will cause the resistance between terminals B and C to (increase) (decrease) (remain the same).

3. When turning the potentiometer counterclockwise, the resistance between terminals A and C will (increase) (decrease) (remain the same).

4. A resistor is color coded RED, RED, RED and no 4th band. It is measured and found to be 1755 ohms. The resistor is (in) (out) of tolerance.

5. When a CdS cell is exposed to more light, the resistance should (increase) (decrease) (remain the same).

6. A thermistor with a negative temperature is cooled and measured with an ohmmeter. Probably the resistance went (up) (down) (stayed the same).

7. The resistance of a carbon composition resistor (can be) (cannot be) determined by the physical size.

8. The larger the size of a carbon resistor, the (more) (less) power it can handle.

9. A standard resistor of 11 ohms will have a 4th band of (gold) (silver) (black). HINT: See Appendix G, TABLE G-3 in your textbook.

10. A 24 ohm resistor will have a 4th band of (gold) (silver) (red).

11. A volume control on a radio is usually a (rheostat) (potentiometer).

12. A noisy volume control probably has dirt under the (knob) (slider).

13. A potentiometer has how many terminals? (One) (Two) (Three) (Four)

14. A rheostat has how many terminals? (One) (Two) (Three) (Four)

15. A 1000 ohm potentiometer shaft is set at 1/2 rotation. The resistance between terminals A and B measure 100 ohms. Probably the "pot" is (bad) (linear taper) (nonlinear taper).

16. If a resistor has "opened", due to heavy current, the ohmmeter will probably read (270kohms) (0 ohms) (infinite ohms).

17. A color coded resistor has a wide 1st band. Probably the resistor is (high value) (expensive) (wirewound).

18. A resistor is color coded with a brown wide band, black narrow band, brown narrow band, and silver narrow band. Probably it has a resistance of (100 ohms) (101 ohms) (210k ohms).

19. The resistor in question 18 has a tolerance of (5%) (10%) (20%) (50%).

20. The resistor in question 18 is made of (carbon) (CdS) (wire) (glass).

21. Which of these resistors is not a standard commercial value?

16 ohms, 5%
22 ohms, 20%
39 ohms, 10%
56 ohms, 20%

22. Which resistor would be the largest physical size?

100kohms, 1/2 watt.   22 ohms, 2 watts.   680kohms, 1 watt.

23. A linear taper 100kohms "pot" is set at one-half clockwise rotation. The resistance from A to B is (the same as from A to C) (the same as from B to C) (100kohms) (200kohms).

24. As the shaft of the volume control on a radio is turned, it causes "scratchy" sounds out of the loudspeakers. The "pot" should be (tapped lightly with a large hammer) (tapped heavily with a small hammer) (replaced or cleaned with alcohol).

25. The type of resistor most commonly used in a 10 watt circuit is the (carbon) (precision) (10 ohm) (wirewound).

Answers to PROJECT 7: Self Evaluation Quiz

1. increase
2. decrease
3. remain the same
4. out
5. decrease
6. up
7. cannot be
8. more
9. gold
10. gold
11. gold
12. "pot"
13. Three
14. Two
15. nonlinear taper
16. infinite ohms
17. wirewound
18. 100
19. 10%
20. wire
21. 56 ohms, 20%
22. 22, 2 watts
23. the same as from B to C
24. replace or clean with alcohol
25. wirewound

TABLE 1

	Examination			Calculate		Measure		
#	Coded Value	% Tol.	Wattage	Column 4 Range of Tolerance		Column 5 Measured Value		Column 6 In Tolerance?
R	Column 1	Column 2	Column 3	Low Limit	High Limit	VTVM	Digital	(use DMM value) Yes/No
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								

UNIT EXAM TEST # ________

RESISTANCE AND RESISTOR

IMPORTANT;

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer for each question - there is only one correct answer for each question.

1. A conductor is a material that provides a high resistance path for a current flow. (T - F)

2. As a wire is made longer, its resistance will increase. (T - F)

3. Equal size pieces of gold wire and aluminum wire would have the same resistance. (T - F)

4. As the diameter or cross-sectional area of a wire decreases, its resistance also decreases. (T - F)

5. Changing the temperature of a conductor will not affect its overall resistance. (T - F)

6. Fixed resistors have the advantage that their resistance values can be easily adjusted by either rotating a shaft, or moving a slider. (T - F)

7. Potentiometers and rheostats are variable type resistors. (T - F)

8. Wire wound resistors generally offer better accuracy and higher power ratings than carbon composition resistors. (T - F)

9. Carbon composition resistors have their resistance value clearly labeled on the body of the device. For example: "1000 ± 10½. (T - F)

10. If a 100 ohm resistor has a tolerance of 10½, its actual value can be between 90 and 110 ohms. (T - F)

ELECTRONICS A QUIZ RESISTOR COLOR CODE TEST # ___________

For questions 1 to 15, the color code is given in the chart below. Read the questions carefully and determine the answer. Then mark the answer on the Scantron Answer Sheet.

1. Resistor #1 has a color coded value of:
a. 473 b. 4700 c. 47000 c. 473.1

2. Resistor #2 has a color coded value of:
a. 105 b. 10,000 c. 100,000 d. 1,000,000

3. Resistor #3 has a color coded value of:
a. 2,000 b. 20,000 c. 200 d. 202

4. Resistor #4 has a tolerance of +/- __________%.
a. 10 b. 20 c. 5 d. 300

5. Resistor #5 has a color coded value of:
a. 622 b. 6200 c. 62,000 d. 5%

6. Resistor #6 has a tolerance value of:
a. 5 b. 10 c. 20 d. 74

7. Resistor #7 has a tolerance value of _______ohms.
a. 5 b. 10 c. 39 d. 390

8. Resistor #8 has a tolerance value of +/- _______ohms.
a. 5 b. 10 c. 510 d. 255

9. Resistor #9 measures 650 ohms, is it within tolerance?
a. Yes b. No

10. Resistor #10 measures 8200 ohms. Is it within tolerance?
a. yes b. No

11. Resistor #4 has a color coded value of:
a. 301 b. 300 c. 3000 d. 10%

12. Resistor #6 has a color coded value of:
a. 74,000 b. 7,400 c. 743 d. 20%

13. Resistor #7 has a color coded value of:
a. 39 b. 390 c. 391 d. 3900

14. Resistor #9 has a color coded value of:
a. 810 b. 811 c. 8100 d. 20%

Resistor #	1st Band	2nd Band	3rd Band	4th Band
1	Yellow	Violet	Orange	Silver
2	Brown	Black	Green	Gold
3	Red	Black	Red	No Color
4	Orange	Black	Brown	Silver
5	Blue	Red	Red	Gold
6	Violet	Yellow	Orange	No Color
7	Orange	White	Brown	Silver
8	Green	Brown	Red	Gold
9	Gray	Brown	Brown	No Color
10	White	Red	Red	Silver

RESISTORS

(ĐIỆN TRỞ)

ADJUSTABLE
RESISTOR : Một loại điện trở điều hoà, nơi cần tiếp xúc di chuyển để chọn lựa số lượng cản điện của điện trở.

CARBON COMPOSITION
RESISTOR : loại điện trở than dùng thông dụng trong các kế hoạch điện. Nó có một dãy cột màu chỉ giá trị (về ohm) cản điện. Resistor có số đo là Ω (ohm).

COLOR CODE: màu sắc được dùng trên Resistor. Hệ thống này có 3 hoặc 4 cột màu được sơn trên trên thân của Resistor để xác định giá trị ohm. Mỗi màu nó sẽ tương đương với 1 trị số

CONDUCTANCE : Chất dẫn điện. Nó dẫn điện hoặc cho phép cường độ điện qua. Đơn vị căn bản của CONDUCTANCE là mho hay siemens. CONDUCTANCE có ký hiệu là G.

FILM RESISTOR : là loại điện trở được làm có sự chính xác hơn và vững bền hơn điện trở than. Loại này có vật liệu chính làm nên là lớp than mỏng, kim loại hoặc oxyt kim loại.

FIXED VALUE
RESISTOR : Một điện trở chỉ có một giá trị cản điện. Nó có thể là điện trở than, dây quấn, hoặc điện trở phim.

Wirewound : quấn dây trào xung quanh 1 điện trở.
Movable (a): di chuyển.
Contact : điểm tiếp xác, giao dịch.
Terminal : phần tận cùng
Adjust : điều hòa
slide : truột, chạy trên
frequent : (a) có luôn luôn. (v) hay đến, năng lui tới.
Impractical : không thực tế, không tiện lợi.
Material : Vật liệu
color band : cột màu
ohmic value : giá trị bằng ohm.
offer : cố làm
accuracy : chính xác
stability : bền vững
layer : lớp (tầng)
metallic oxide: oxýt kim loại
potentiometer : biến trở kế
Potential : điện vị
Variable , đổi khác
consisting : gồm có
arm : cánh tay
movable arm: cánh tay di động
output : phát ra
Rating , Số lượng, chức phận.
Rheostat máy biến trở
opposition : sự chống lại
oppose : cản
flow : chạy
measure : đo
Tolerance : sai số, độ sai biệt.
vary : biến đổi, đổi khác.
still : cho đến khi
considered : coi như là.
Percentage : bách phân, phần trăm %.
variable : biến đổi
continuously : một cách liên tục
wattage rating: chức phận của watt (công suất tiêu thụ)
overheat : nóng lên
burn-up : bị cháy mất
wire gauge : cỡ dây, cỡ dây điện (lớn → nhỏ)
The larger ... The smaller: càng lớn... ... càng nhỏ....
combination : sự kết hợp
winding : cuộn, quấn

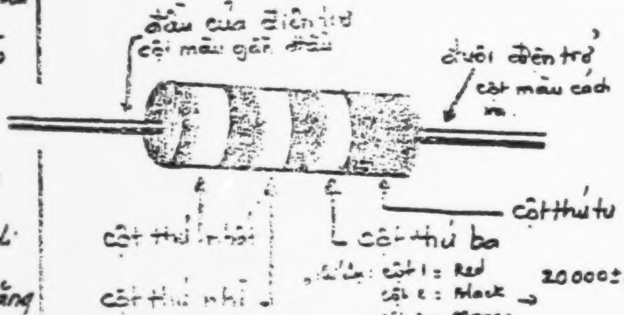
SCORE	ghi điểm.
GRADE	hạng, bậc.
WORKSHEET	chỉ tờ giấy để thực tập.
DEFINITION	sự định nghĩa.
OWN word	chữ riêng (của học viên).
SKETCH	nét vẽ sơ lược.
APPROPRIATE	Thích hợp, thuộc riêng, để riêng ra.
CODE	qui tắc, qui luật
COLOR CODING	qui tắc màu của điện trở.
DECODING	dịch Ra bằng trị số.
Band	cột màu của điện trở
First band	cột thứ nhất
Second band	cột thứ nhì
third band	cột thứ ba
fourth band	cột thứ tư
Black	màu đen (0)
Brown	màu nâu (1)
Red	màu đỏ (2)
Orange	màu cam (3)
yellow	màu vàng (4)
Green	màu xanh lá cây (5)
Blue	màu xanh da trời (6)
violet	màu tím (7)
Gray	màu xám (8)
white	màu trắng (9)
silver	bạc = ±10%
gold	vàng = ± 5%
None	Không có màu sắc (chỉ cột số 4 None có nghĩa là không màu = ± 20%)
Technique	kỹ thuật
converting	việc biến đổi
equivalent	tương đương
Number of zeros	số lượng của các số zero
Extra challenge	việc thử thách lớn
Gold	ở cột màu số 3 (Thứ 3 có màu là Gold có nghĩa là chia cho 10
silver	ở cột thứ 3 có nghĩa là chia cho 100

assigned : chỉ rõ
tolerance ranges: độ sai biệt cao nhất và thấp nhất cuả điện trở.
upper limit : giới hạn cao nhất.
lower limit : giới hạn thấp nhất.
puppets : mẫu in rồi dùng để cắt dán lại.
attached : được dán, buộc
color pencils : các bút chì màu
shade : đánh, tô (màu)
Compute : tính (toán)
Digit : chỉ số từ 1 đến 9 (1, 2, 3 ... 8, 9.)
complicate : phiền phức, rắc rối.
Even though : mặc dầu, thế vậy.
actually : thực sự, thực tế
hang : giữ, treo
Remember : nhớ, ghi nhớ.
represent : đại diện, thay mặt
basically : căn bản (tính chất)
add : cộng
indicate : chỉ định, chỉ rõ

Function : chức phận, nhiệm vụ.
general : thông thường
implies : bao hàm, hiểu ngầm
flow : chạy (cường độ).
require : đòi hỏi
task : công việc
reduce : giảm, (bớt), cản.
fixed : đứng yên, cố định
volume control: kiểm soát dung tích (sức chứa)
interchangeable: có thể giao dịch
describe : mô tả
style : kiểu, thể
shaft : căng
slider : tay di động (vật trượt trên điện trở)
contact : giao dịch
application : sự ứng dụng.
specific : đặc biệt
worry : lo lắng
about : về, nói về
polarity : cực
oriented : được định hướng
also be aware that cũng nên biết rằng

produce	sinh ra
heat	sức nóng
operating	làm việc
sirious burn	cháy (đứt) trầm trọng.
So be cautious	Như thế Hãy thận trọng.
handling	xử dụng
recently	vừa qua, mới vừa
turned off	(nghĩa bóng) vừa cháy đứt
wiper	chổi quét (tay của điện trở di chuyển làm tăng hoặc giảm sức cản điện
construct	xây dựng, thiết lập
either .... or..	hoặc .... hoặc ....
important	quan trọng
Specification	- yếu tố đặc biệt - một điều nói ra
Greek letter	chữ Hy Lạp
Specified	được ghi rõ
Fraction	phân số

electrical power	công suất điện.
Safely	an toàn
dissipate	tiêu thụ
as heat	khi nóng
figure	con số
variation	sự biến đổi
Somewhere	một số nơi



Thí dụ: cột 1 = Red
cột 2 = Black → 20000 ± 20%
cột 3 = Orange
cột 4 = None

- Trong trường hợp này cột thứ tư không có màu sắc chỉ định trên điện trở ta biết rằng: đó là None tức là ± 20% (Thay vì cột thứ tư có màu hoặc là Gold hoặc là Silver thì trị số sai biệt chỉ là ± 5% cho Gold và ± 10% cho Silver).
- Ở cột thứ 3 là cột màu có trị số gồm một hay nhiều số không (zero) đứng liền sau cột thứ nhất và cột thứ nhì. Nếu cột thứ ba có màu Gold thì lấy cột 1 và cột 2 chia cho 10; nếu cột thứ ba là Silver thì lấy cột 1 và cột 2 chia cho 100 (Trường hợp này rất hiếm gặp).

Thí dụ: cột 1 = Red
cột 2 = Black ta được trị số ohm
cột 3 = Gold $\frac{20}{10} = 2\Omega$

LII-U12-6

電阻器 RESISTORS

技術語彙

可調电阻(ADJUSTABLE RESISTOR)：附有移动接点的一种线绕型電阻 移动觸点与两端点之间电阻可以利动点之滑动而变化，此類电阻器設計成若時常調整则不宜险。

碳电阻器(CARBON COMPOSITION RESISTOR)：被用於电子業中最普通的电阻器，碳化合物為其电阻物质，其外層用一組顏色環来標示其电阻值(欧姆值)(ohmic value).

顏色符号(COLOR CODE)：一組有三環或四環顏色有系统地塗在电阻器上以標示其欧姆值。每一顏色及環顺序代表相等的數值、

电導(CONDUCTANCE)：計量導线傳導电流之能力。其基本單元為姆欧(mho)或西门子(siemens). 文字代表為：G

薄膜电阻器(FILM RESISTOR)：比碳电阻器更精確更穩定的一种电阻器，其用一薄層的碳化合物，金屬或金屬氧化物為电阻物質。

定值电阻器(FIXED VALUE RESISTOR)：只具一個电阻值的电阻器，其構造可為碳电阻器，线繞电阻器及薄膜电阻器。

欧姆值(OHMIC VALUE)：电阻器的欧姆數值.

分压器(电位計)(POTENTIOMETER)：具有电阻体及刹动柄的一种可变电阻器，有一端子(terminal)与电阻体两端及刹动柄均相接連，其輸出之电阻可由刹动柄来調整.

LIZ-U12-7

当其三个端子均接在电路上,则称此配件為分压器(potentio
ter).若只将位於中间的滑动柄端子及一頭电阻物质的端子
接在线路上,则称此配件為变阻器(rheostat)

电阻器(RESISTOR):用以阻抗电流通过电路的电子组件.电阻
設計以提供特定之电的阻抗力(电阻)以对抗电流,其电阻
計量單元為歐姆(ohms).符号:∿∿,文字代表為:R

誤差(TOLERANCE):此电器组件上標示之值有差别的數值.但依
考慮該組件為可用品.此數值用百分率表示,例如:標示值
1000Ω(一千歐姆)有10%之誤差.即表示在900Ω至1100Ω之间
範圍此电阻器依然為可用品。

可变电阻器(VARIABLE RESISTOR):設計成很容易調整至不同电阻
的电阻器.其提供在其本身範圍值内可連續地改变电阻值
例如:1000Ω之可变电阻器可改变在0至1000歐姆之间任何
數值.分压器(potentiometer)及变阻器(rheostat)则是。

瓦特數(WATTAGE RATING):电阻器能承受多少能量(功能)与其
身之体形大小有関。过量的功能(power)可使电阻器过热
或烧坏.

电线粗细尺規(WIRE GAUGE):計量導线粗细直径的單元系统
美國導线尺規(American Standard Wire Gauge)系统,用由0000
至6,40類尺規。尺規号碼愈大導线直径愈小。

线绕电阻器(WIREWOUND RESISTOR):具有高精確性及耐高功率的
一种电阻器.其以特别电阻线捲绕在一绝缘柱心上而成

wirewound = 以电线绕捲在心柱上.如线绕电阻器.

movable = 可以移动的.

contact = 接觸.相碰觸.

terminal = 端子.接頭点,线端

adjust = 調整

slide = 滑動

frequent = 经常的,頻繁的

impractical = 不合实際的.

material = 物质.

color code = 以颜色環作符號以代表數值.

ohmic rate = 电阻的表示單元,稱之歐姆值.Ω.

offer = 供应,提供,供給.

accuracy = 準確性.

stability = 安定性,穩定性

layer = 層,一層一層地.

metallic oxide = 金屬氧化物

potential = 电位差,电压

variable = 可改变的

consisting = 组成,存在.

arm = 柄,軸.

output = 輸出.

rating = 值,率.

opposition = 反对,抗拒.

flow = 流动

measure = 計量、测量

percentage = 百分比率.以%表示.將任何一數目除100所得之數(商)附上%則是。

continuously = 連續地.

combination = 合併在一起.

winding = 纏繞,捲繞.

tasks = 工作,運作.

reducing：降低，减少

limiting：限制.

fixed：固定的

volume control：音量控制，音量調節.

shaft：軸

slider：滑桿

both ends：兩端，兩頭

center：中间，中心.

internal connections：内部連结

devices：配件、零件、组件、設備.

polarity：極性，指"+(正)""-(負)極

oriented：定向

aware：提醒.注意

produce：產生.

cause：發生產生.

serious burns：嚴重的燒燃.

cautious：小心.注意.

turned off：闵掉.

wiper：刷柄，刷桿.

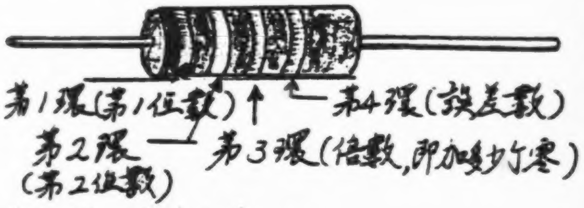
represented：代表，表示.

wattage：功率，瓦特數，以watt為基本
單元.

figure：數目字.

normal：正常的，標明正组件上的數值

color code：色環号碼



例如第1環為紅色＝2
〃2〃〃紫色＝7
〃3〃〃橘色＝加三个零，000，橘色為
第4〃〃沒有顏色＝±20%

則該电阻器电阻為 27000Ω±20
表示电阻在 27000×20%
$=27000\times\frac{20}{100}=5400\,\Omega$
$27000-5400=21600\,\Omega$
$27000+5400=32400\,\Omega$

在21600Ω與32400Ω之间則為良
或可用品.

第4環為銀色＝±10%
〃4〃〃黄金色＝±5%

若第3環為銀色,則不是加多少個零而是要"除100"或"乘0,01"
" " 3 " "黄金色," " " " " " " " " "除10"或"乘0,1".

percentage range = 百分率範圍.

某數值的百分率是用"%"(百分符号)表示之.其誤錯均有一範圍.故
百分率有上限(upper limit)及下限(lower limit)用"加"号及"減"号表
例如某电阻器之电阻值為180Ω±10%.其數值計算法如下

$$180 \times \frac{10}{100} = 18$$ (10%即稱"百分之10")

上限為 $180+18 = 198$ (180Ω+10%)

下限為 $180-18 = 162$ (180Ω−10%)

故欲測得該电阻器之电阻在162Ω至198Ω之间,即表示其值
在誤差範圍内,則為可用品.

tolerance range = 誤差範圍由(from) 198Ω 至(to) 162Ω.

black	黑色	0
brown	棕色	1
red	紅色	2
orange	橘色	3
Yellow	黄色	4
Green	綠色	5
Blue	藍色	6
Violet	紫色	7
Gray	灰色	8
white	白色	9.

你可发现其色環排列是由深色向浅深順着排的.